ERIC Document Resume	See Instruction Sheet	DATE OF RESUME	DATE RECEIVED

A. PUBLICATION DATA

1. ERIC NUMBER	2. ORIGINATOR CONTROL NO(S).	3. IDENTIFICATION NO.
ED001270	N.A.	OE-29029

DO NOT WRITE IN SPACE BELOW

4. AUTHOR(S):
Piltz, Albert

5. TITLE OF DOCUMENT ABSTRACTED:
Science Equipment and Materials for Elementary Schools

6. PUBLICATION TITLE:
N.A.

7. EDITOR(S):
N.A.

8. PLACE OF ORIGIN
ORG. Office of Education
Dept. of HEW
ST. Washington, D.C.
CITY, STATE

9. PUBLISHER OR SOURCE
Office of Education
Dept. of HEW

10. VOL.	11. PAGES	12. MO./YR.	13. TOTAL PP.
N.A.	N.A.	61	72

TELE. EXT.
INST/LOC CODE

MICROFILM COPY AVAILABLE
YES ☒ NO ☐

COPYRIGHT GRANTED
YES ☐ NO ☒

COPYRIGHT RELEASE FILED
YES ☐ NO ☐

TYPE OF REPORT
PROPOSAL ☐
IN-PROGRESS ☐
FINAL ☒
FOLLOW-UP ☐

OTHER ERIC REFERENCES:

ERIC SATELLITE CODE

B. INDEXING DATA

14. SUBJECT AREA

15. TYPE OF ENDEAVOR
manual

16. INDEXING TERMS (6-12)

program planning	equip. acquisition	elementary science	teacher orientation	
teaching aids	teaching science	safety regulations	classroom	activities
science equip.	science programs	administrative planning	science equipments	
		equipment selection		

17. ABSTRACT (MAX. 250 WORDS) A new emphasis on science in the elementary school has stimulated supervisors, administrators and many teachers to seek information on sources, selection and use of appropriate materials and equipment in instruction. This bulletin is mainly to help the neophite who is interested in the basics of elementary science teaching. The discussion is keyed particularly to the needs of the elementary school supervisor, principal, and others responsible for school policies regarding the procurement and use of science equipment. In planning a basic elementary science program the following concepts should be kept in mind: a continuum of science from kindergarten through high school is widely accepted as necessary in preparing young people to understand the impact of science and technology upon their lives; the elementary classroom needs to be equipped with all the up-to-date tools and devices which improve instruction; the "science corner" of earlier days is giving way to classroom facilities which make science an integral part of the elementary school program; science instruction can be greatly strengthened by the acquisition and utilization of adequate equipment and materials; effective use of equipment in science instruction can best be achieved when teachers and administrators understand its relation to the program objectives; since equipment is determined by the nature of the instructional program, criteria for planning the facilities may be derived by examining the characteristics of good science learning activities; the selection of material and equipment should never precede the science program. Building a program around equipment brings into serious question the soundness of teaching practice. The topic headings for general discussion include: 1.) equipment, material and facility requirements for a good science-learning activity, 2.) selecting equipment and materials for a science program, 3.) orienting teachers to the purpose and use of equipment and materials, 4.) school policies regarding use of science equip., and 5.) budgetary and procurement practices.

ERIC No.

18. SOURCE OF ABSTRACT

C. FUNDING DATA

19. SUPPORTING ORGANIZATION	20. DIVISION OR DEPT.	21. CONTRACT NO. / PROJECT NO.
	22. TOTAL COST OF PROJECT	
	23. DURATION OR PROJECT	U.S. Department of Health, Education, and Welfare Office of Education

REPRINTED BY PERMISSION
U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
OFFICE OF EDUCATION

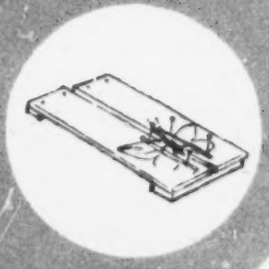
THIS DOCUMENT HAS BEEN PRINTED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

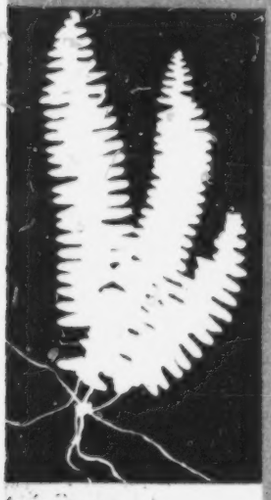
371.66
ED001270

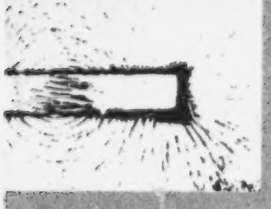
OE-29029

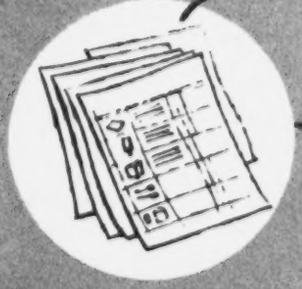
Science Equipment and Materials

FOR ELEMENTARY SCHOOLS









U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE • Office of Education

Highlights

- A continuum of science from kindergarten through high school is widely accepted as necessary in preparing young people to understand the impact of science and technology upon their lives.
- The elementary classroom needs to be equipped with all the up-to-date tools and devices which improve instruction. The "science corner" of earlier days is giving way to classroom facilities which make science an integral part of the elementary school program.
- Science instruction can be greatly strengthened by the acquisition and utilization of adequate equipment and materials.
- Effective use of equipment in science instruction can best be achieved when teachers and administrators understand its relation to the program objectives.
- Since equipment is determined by the nature of the instructional program, criteria for planning the facilities may be derived by examining the characteristics of good science-learning activities.
- The selection of materials and equipment should never precede the science program. Building a program around equipment brings into serious question the soundness of teaching practice.
- Understanding of the principles of science is not achieved in a day; it grows gradually out of a variety and continuity of experiences. The significant factors are the teacher and the activities which pupils engage in each day.

371.66 1270

OE-29029
Bulletin 1961, No. 28

Science Equipment and Materials

FOR ELEMENTARY SCHOOLS

SUGGESTIONS FOR SUPERVISORS ADMINISTRATORS AND TEACHERS

By
ALBERT PILTZ, *Specialist, Elementary Science*
Science, Mathematics, and Foreign Language Section

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
ABRAHAM A. RIBICOFF
Secretary

Office of Education
STERLING M. MCMURRIN
Commissioner

Educational Materials Laboratory
Office of Education

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1961

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 30 cents

Foreword

THE PHENOMENAL GROWTH of science and technology in the past decade has made science teaching more important, and at the same time more difficult. An awareness of these changes has caused an unprecedented public support for sound science programs in the schools.

A good science program makes effective use of equipment and materials in teaching basic science concepts. The National Defense Education Act of 1958, Title III, has provided educators with greater opportunity to strengthen instruction through the acquisition of needed equipment and materials.

A new emphasis on science in the elementary school has stimulated supervisors, administrators, and many teachers to seek information on sources, selection, and use of appropriate materials and equipment in instruction. This bulletin is intended mainly to help the neophite who is interested in the basics of elementary science teaching. It offers general guidelines concerning the relationship of equipment to the various elements of the instructional program. The discussion is keyed particularly to the needs of the elementary school supervisor, principal, and others responsible for school policies regarding the procurement and use of science equipment.

E. GLENN FEATHERSTON
Assistant Commissioner
Division of State and Local School Systems

JOHN R. LUDINGTON
Director, Aid to State and Local Schools Branch
Division of State and Local School Systems

Contents

	Page
Foreword	iii
Introduction	1
Equipment, Material, and Facility Requirements for a Good Science-Learning Activity	7
Planning the Facilities	7
Determining Needs for Materials	12
Industrial and Commercial Materials	18
Selecting Equipment and Materials for a Science Program	20
Equipment in Relation to Program	20
Projection Equipment and Materials	21
Kits, Carts, and Package Material	25
The Place of Commercial and Improvised Equipment	27
Organization, Storage, and Distribution of Equipment	30
Orienting Teachers to the Purpose and Use of Equipment and Materials	32
Inservice Meetings and Equipment Committees	32
Materials Centers	34
Mobile Science Laboratories	35
Helpmobiles and Drive-in Conferences	35
School Policies Regarding Use of Science Equipment	36
Safety Regulations in Planning Equipment Needs	36
Field Trips and Excursions	39
General Suggestions	41
Budgetary and Procurement Practices	43

TYPES OF EQUIPMENT LISTS—SELECTED SAMPLES 46

APPENDIX I.—Basic, Standard, and Advanced Lists for Elementary Science—Council of Chief State School Officers.. 51

APPENDIX II.—Science Supplies and Equipment for Elementary Schools, Grades 1–6—Detroit Public Schools.... 55

APPENDIX III.—Science K–6 Equipment and Supplies—New York State Education Department 61

APPENDIX IV.—A Basic Equipment List—National Science Teachers Association 64

APPENDIX V.—Science Equipment—Denver Public Schools.. 66

Introduction

IN THE PRESENT PERIOD of extensive program revision in the sciences, elementary school science is of particular concern, both because it often has been a neglected area in the elementary school curriculum and because elementary science is basic to program improvement in junior and senior high school science. The child's environment, as it expands rapidly with new "breakthroughs" in science and technology, offers unlimited opportunity for science learning. New science publications are appearing almost daily for the use of pupils, teachers, and administrators. Audiovisual aids are in greater abundance. The quality of the science program, therefore, is related to the quality of facilities, supplies, materials, and equipment. Since these are basic to a good teaching-learning situation, they require special attention in the overall planning of a science program.

Facilities and equipment, of course, are determined by the type of science activities in the school program. Certainly programs of science should be in harmony with the purposes of the total program of education which, in the main, helps children gain values, understandings, and skills consistent with good citizenship in a democratic society. Each school must define its own objectives before making decisions concerning equipment and materials. Although many specific aims might be suggested, the following are representative of the general objectives found in most elementary school science programs:

1. Build science experiences around the solving of problems which are significant to boys and girls.
2. Provide activities which aid children to gain skill in the use of many methods of finding out things for themselves.
3. Enlarge upon children's ever-present curiosity and interest in the world around them, helping them gain an appreciation of the potential of science and technology for improving man's welfare, and alerting them to the dangers of misuse of scientific knowledge.
4. Select experiences which aid children to understand some generalizations and principles of science applicable to the solving of problems in their environment.
5. Show that advances in science require freedom of thought and inquiry.
6. Illustrate the relation of science to other areas of knowledge.

Perhaps the great appeal of science for children is activity. With

Courtesy, Valdosta Public Schools, Valdosta, Ga.

Pets foster a growing interest in science.

the help of materials and equipment, the child investigates and makes discoveries which are as exciting to him as to the original discoverer. Firsthand experience not only helps him to see relationships and make applications, but it also helps him develop skills and resourcefulness. Sometimes children may pursue individual interests within a general area. For example, if the area of study is weather, interests in air, temperature, evaporation, and forecasting would naturally arise, and activities would follow with each youngster contributing to the general theme. At other times a problem introduced in challenging fashion, whether by a pupil or the teacher, may prompt group activity for its solution. The following class activity in problem solving is illustrative.

While Jim was engaged in feeding fish in the classroom, he noticed a ring around the glass aquarium where the water level had receded. Curiosity prompted him to inquire of the teacher where the water had gone. "What do you think happened to the water?" the teacher asked the entire class.

The children were given opportunity to speculate (hypothesize) and to check or test their ideas and reject them if these ideas were found to be invalid.

Several members of the class examined the bottom and sides of the aquarium with great care to see if the water had leaked out but discovered the outside was quite dry. Mary wondered if the fish drank the water. Bill thought the plants may have used some of it.

One by one their notions were disproved in the light of tested evidence. The inductive method was used where possible. Activities

employing skills in investigation, experimentation, and reading were utilized. Elements for building scientific attitudes were introduced, such as careful observation, suspending judgment in drawing conclusions until sufficient evidence warrants it, understanding cause and effect relationships, respecting points of view that scientists hold, openmindedness, and intellectual honesty.

When Jim suggested that the water could have gone into the air, the group decided to experiment to test his idea (hypothesis).

The children were now investigating on a level commensurate with their interest and ability and developing concepts about scientific method and content.

Proposals for ways of finding out—to experiment—were made by the children. Materials to perform an experiment were carefully outlined by the class.

This led to other problems, and more science information was required to effect a solution.

Having decided on procedure and organization, the children selected two containers of identical size and composition, filled both with water, capping one (the control), but not the other (the test and single variable), so that results could be compared.

When the children arrived at a conclusion, they generalized and related their finding to the two jars, not the whole universe of jars. Later the

Courtesy, Springfield Public Schools, Springfield, Mo.

Children try things out with equipment brought from home.

pupils filled several containers with water, leaving some open and capping others.

They learned about the nature and purpose of scientific experimentation. They learned the principles of evaporation and decided to test them further. Each time they experimented, controls were used.

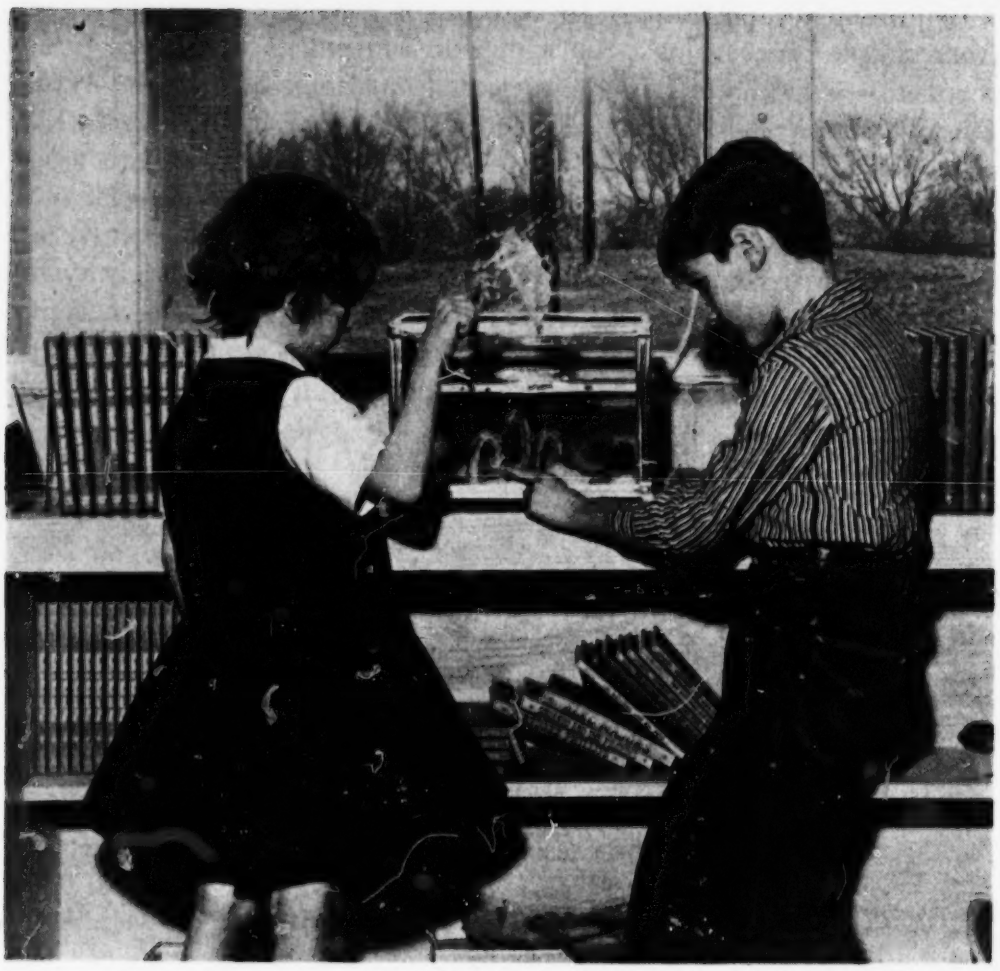
The children now filled vessels of different shapes and sizes with water to discover whether surface area made a difference in rates of evaporation. Later they tried alcohol and kerosene to see if dissimilar liquids made a difference in the rate of evaporation. Then they tried to find out the effects of temperature and wind on the evaporation of liquids and drew conclusions after checking their data.

Application of the principle of evaporation was made by Jim who remarked, "I know why mother hangs clothes out to dry on a warm windy day. Water evaporates more quickly when it is warm and windy outside." The materials used in the experiment were simple, easily obtainable, and appropriate to the solution of the problem.

In science activities, children have opportunities for utilizing skills learned in other curricular areas. A child constructing a model airplane, measuring the wingspan, or computing fuselage dimensions applies arithmetical concepts in his work. He is provided with li-

Courtesy, Detroit Public Schools, Detroit, Mich.

Careful observation of living things brings understanding.



Courtesy, Wichita Public Schools, Wichita, Kans.

Curiosity may lead to discovery.

brary experience when he investigates the nature of a specimen collection. Attempting an experiment from his reading, and recording the results, brings into use his language arts skills. In keeping with the purposes of general education to unify and integrate experience, science draws from all areas of the curriculum.

Science activities vary in length and importance, depending upon the interest of the learner and the nature of the problem. Some activities may require only a class period or less; others may extend over a semester or even a year. For example, superstitions such as those that snakes are slimy or can stand on their tail can be easily disproved by examining a few snakes in the classroom for a relatively short time; if, on the other hand, children want to find out whether plants change as the seasons change, a series of excursions may be required throughout the year, and this would involve preparation, note-taking, making collections to compare changes, art skills, and many "on-going" experiments.

Requirements pertaining to equipment and materials also vary from simple observations, for which no equipment is needed, to experiments or field study involving numerous items of different types. The role of the teacher is to help the child discover facts and relationships for himself, rather than to tell him the answer, and to assist him in demonstrating principles by performing simple experiments for which suitable equipment and material have been carefully selected or improvised. Originality of thought and action is always to be encouraged. The teacher also insures purpose in science activity and sees that it has lead-on value so that it opens up new "needs to know" and increases the learner's confidence in his ability to find the answers.

Equipment, Material, and Facility Requirements for a Good Science-Learning Activity

ADMINISTRATORS are constantly striving to provide the best setting possible for learning. All manner of science activity requires enough room for the pupils to manipulate materials, explore, demonstrate, experiment, and carry out both individual and group investigations. Although the type of organization necessarily affects the facilities and the equipment needs, a given curricular organization —whether the self-contained classroom or departmentalized program —does not of itself assure that better learning will take place. The significant factors in a good science-learning activity are the teacher and the quality and kind of activities the pupils engage in each day.

Planning the Facilities

In the early development of programs in science it was common to find a small corner of the classroom set aside for science. This might consist of a table or open shelf upon which collections, specimens, and models were placed for viewing. A potted plant, an insect cage, an aquarium, or a terrarium might be found on an improvised stand, window ledge, or table. It was not unusual to find dust-laden objects, or science "clutter," in a disorganized display. Science tended to be an appendage to the school program.

As schools change from a token inclusion of science to a bona fide kindergarten to 12th-grade science program, the elementary classroom will need to be equipped with the up-to-date tools and automated devices which improve instruction. Now, as in the past, there is a place for improvised equipment and material, if the learning to be derived from the experience justifies the time and effort expended in the "making." Classroom construction, furniture and fixture choices, and equipment installations should, however, remove science from the "table," "center," or "corner" setting of a room and make it an integral part of the school program. Keeping in mind the physical environment, purpose, and use of facilities, teachers should select items for rooms in which elementary science is taught for the purpose of creating a situation that will stimulate and promote science learning. The following list of suggested items includes the

basic equipment considered by most modern schools in making a selection. This, or similar lists, should be used, with standards devised by teachers in cooperation with other school personnel, when science equipment is selected.

Demonstration tables, permanent

Many demonstration tables of a standard type, with specially treated tops, and high enough to allow for clear vision of demonstrations and experiments, are used in elementary school classrooms.

Demonstration tables, mobile

In schools where proper utilities are lacking or improperly located, portable demonstration tables are sometimes used. There are a variety of types available to schools. Usually, the mobile table is intended to provide laboratory facilities. Some portable tables are constructed with chemically resistant tops; tackboard or pegboard space for display; a small stainless steel sink with a pump faucet, fresh water and waste tanks (polyethylene carboloys); adjustable shelves; fiberglass apparatus trays; removable Greenlaw arm; and an electrical receptacle with 15-foot cord. The desk is mounted on four rubber-wheeled swivel-type lock casters. The unit is completely self-contained; no plumbing connections are required.

Teacher's desk

Standard with drawers (1 per room).

Multipurpose table

Approximately 48 inches long by 30 inches wide by 30 inches high (1 or 2 per room).

Chair, teacher's

18 inches high (2 or 3 per room).

Stool

With tubular metal frame, 4 legs, wood seat, 24 inches high (1 per room).

Germinating beds

In elementary schools where there is no provision for a conservatory or plant room, a germinating bed could fit into the section of a wall counter. The bed should be portable, on casters or gliders, and zinc-lined. Three 20-gallon garbage pails for peat, soil, and sand, on a dolly, would supply some indoor needs in plant work.

Storage cabinets or cases

Teachers always need storage space for materials, equipment, and supplies. As many cabinets and cupboards as possible should be included in the plan for a room where science is taught. Cabinets for chart storage may be constructed without shelves and for collections of various kinds, such as rocks, insects, botanicals, etc., with specially designed adjustable shelves.

Bookcases

Open bookshelves should be built along a section of the room for both basic and supplementary books for use with pupils.

Vertical file cabinet

A four-drawer, built-in vertical file cabinet saves space and is useful for records and visual materials. It should be easily accessible to the teacher.

Chalkboard

Section chalkboards are usually situated in front of the room.

Projection screen

A standard projection screen may be mounted 18 inches to 24 inches above the chalkboard. Instead, sometimes the wall above the chalkboard is

Courtesy, Louisville Public Schools, Louisville, Ky.

The elementary science program draws from a variety of activity.

painted white, for approximately 5 feet by 7 feet, and is used as a projection screen.

Displayboards

Science bulletin boards have been found to be valuable aids to learning; corkboards and pegboards with fixtures should be placed in available wall areas.

Student tables and seats

Since activity involving materials and equipment requires work facilities, student tables may replace seats with arm rests, with standard chairs to accompany the tables.

Tables should vary in height from 25 inches to 30 inches, according to the age group taught in the room; and the student chair, from 14 inches to 16 inches.

Special room features

A large closet could serve as a darkroom, storage area, and preparation room. Sometimes a small room could adjoin two rooms and be used for the same purposes by both rooms.

Lighting

Trends in illumination favor fluorescent lighting. Fluorescent lighting is being used successfully in new room construction. Window glass should be of a type to permit enough light to pass through for plant growth experiments.

Floor

Floor surfaces should be durable and resistant to liquids.

Courtesy, Loch Raven School, Loch Raven Village, Towson, Md.
Interest in science promotes creative activity.

Chart or map rails

Since more chart material is being made available, a map rail for attachment can be very useful.

Counters, built-in and sectional

Wall counters, with storage space and doors below, have been used successfully by elementary science teachers. The counters are usually installed along the window side of the room. Many models contain a sink and running water at one end of the counter-shelf. Some commercial designs are produced in 4-foot sections. An average classroom would require about five of these sections. Wall-counter sections which are mounted on gliders or casters can be moved easily into any desired positions.

Darkening facilities

Light-tight rooms are needed where projection and experiments require darkness. Pull drapes, opaque roller shades, venetian blinds, adjustable louvers, or jalousies are devices which may be used for darkening a classroom.

Clock

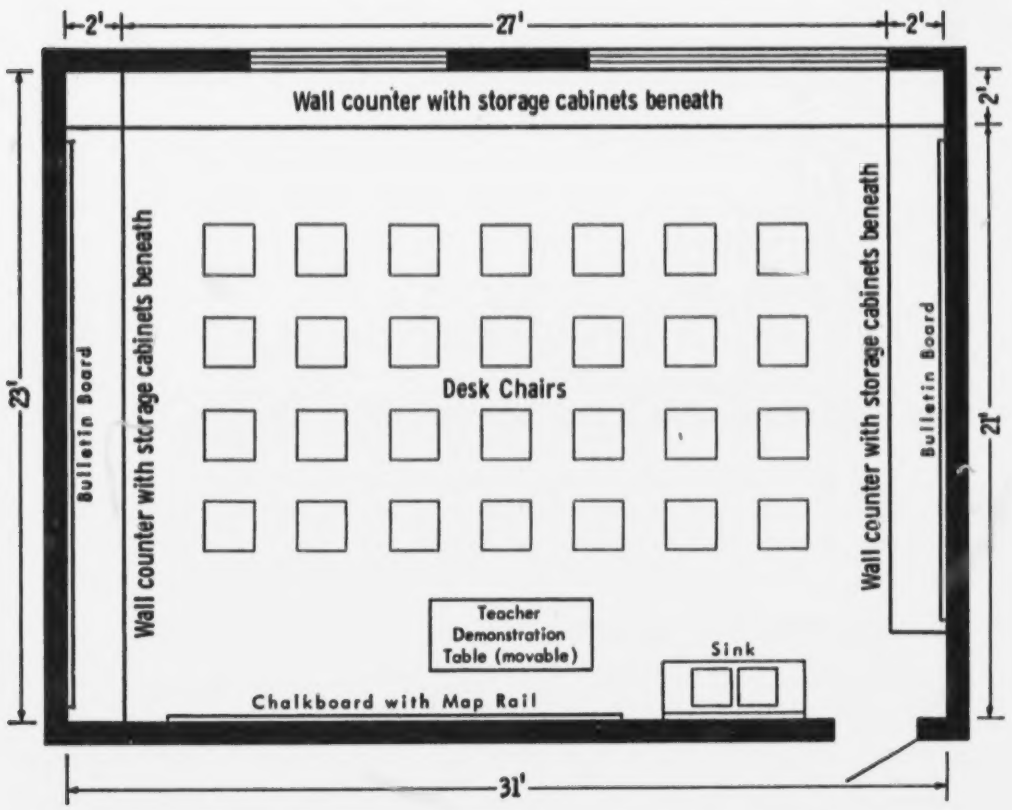
A clock with a large, clear face is useful.

Electric outlets

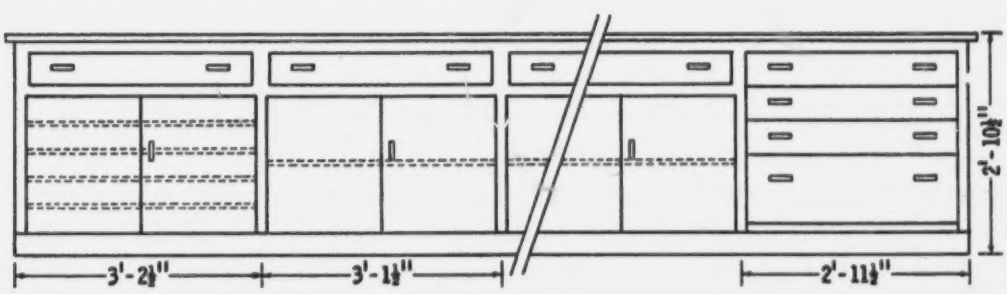
Electrical outlets should be sufficient in number for equipment needs.

The number and variety of activities planned for science instruction require that many facilities be flexible and multipurpose in design to allow changes as programs change. Regardless of the type of curricular framework in which science is taught, rooms should contain utilities considered basic to the program. Running water, heat, and electrical outlets are essential for many experiences in elementary school science.

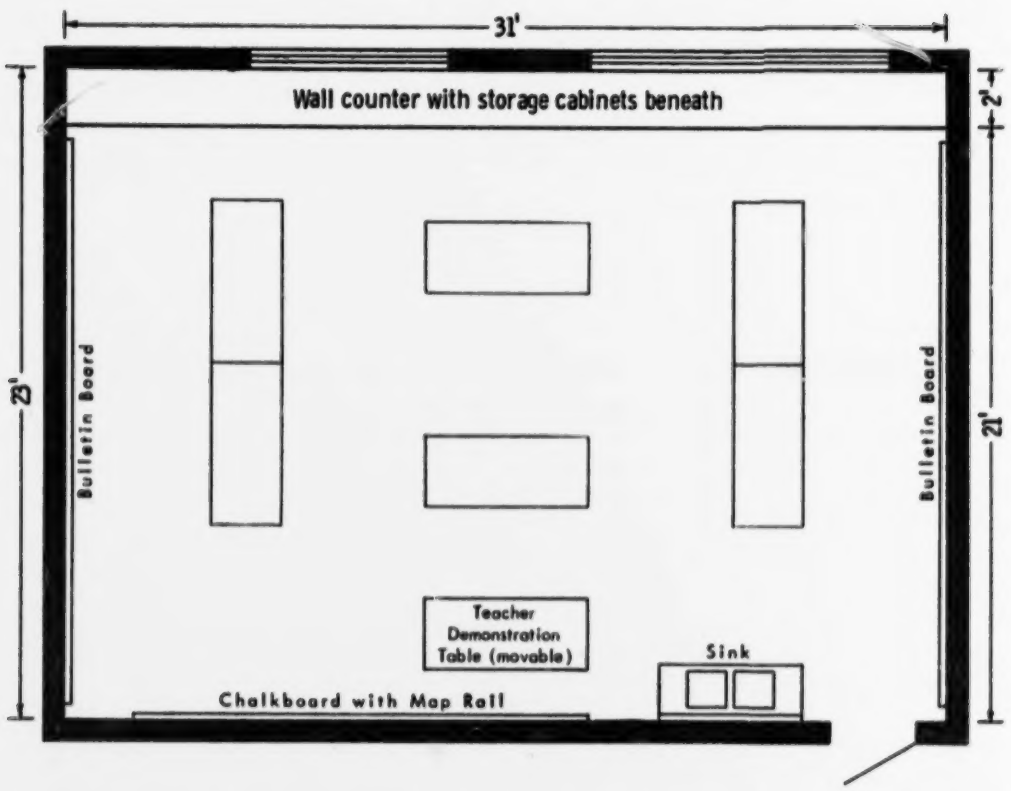
The illustrations of room layouts on this page and the next include the basic furniture considered by many modern schools when science classrooms are designed. It is recognized that any room design is individual and unique and consistent with the school program. The number, and particular arrangement, of seats should also conform to school philosophy and the tenets of the program.



Where desk chairs are used, the perimeter arrangement of wall counter with storage cabinets beneath affords the teacher room for storage and the pupils, space for display and activity.



This type of wall counter facilitates storage of various mounted collections. These collections may be placed in specially designed drawers of the cabinets at the ends of the counter.



Where tables are used in the classroom for activity work, the wall counters may be used for displaying various projects and on-going experiments.

Determining Needs for Materials

Many types of science books—textbooks, trade, supplementary, and reference—are commonly found in elementary classrooms and have become basic to the program. There is a great variation in their use, according to the ways that science is taught, but reading is an important tool in teaching science. Children involved in science study may use books as a basic source of material for learning, as supplements to the textbook, as aids in pursuing an individual interest, as a source of new information, or as a check to find out whether their results in an experiment agree with what authorities have written. Teachers may use books only for an occasional reference or merely for ideas which they develop with children in discussion and demonstration. They may, however, rely on texts to such an extent that science becomes mostly a reading activity. A skillful teacher attempts, instead, to maintain a balance between reading and other learning activities and makes selections on the basis of what is best for the pupil in a given learning situation.

When providing firsthand experience for pupils is not feasible, teachers may use motion picture films and filmstrips to bring reality

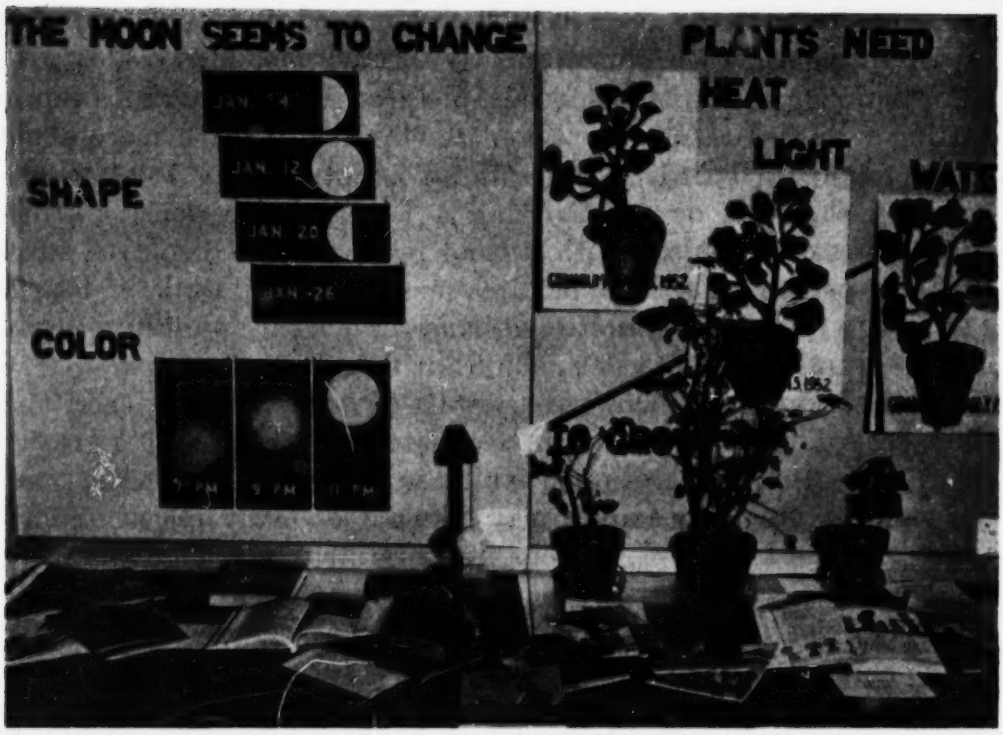
closer to the children. Visuals may also be used to provide emphasis or depth to experience gained directly through field study.

Well arranged graphic materials, pictures, and photographs representing a science theme can stimulate children to learn more about science. Bulletin boards may be useful in introducing a lesson, developing concepts, or summarizing a learning experience. Often three-dimensional objects with various realia may be displayed effectively in combination with pictures and captions. Bulletin boards can also be used with exhibit tables and serve as an interesting backdrop to dramatize the models, object, or specimens displayed.

Children enjoy displaying the results of activities in science, and often the exhibits of their efforts stimulate other children to a greater interest in science. A classroom exhibit is a dramatic way to illustrate science progress. The exhibit may take one of many forms. Sometimes projects include collections of materials that tell a story; or a diorama or cyclorama may depict the habitat of some prehistoric animal. Experiments and demonstrations are also popular, and the design and purpose generally accompanies them. Sometimes note-

Courtesy, Peabody Laboratory School, Milledgeville, Ga.

Reading is an important tool in learning science.



Courtesy, Pitcher School, Detroit, Mich.

Display material and realia stimulate children to learn more about science.

books, charts, graphs, and pictorial material show the particular interest of a youngster by the study required and the effort put forth to perfect the particular project. Sometimes classroom exhibits may become organized in a science fair. Many science fairs originate in classrooms and expand to the whole school and the community.

A specimen from the out-of-doors observed in a classroom permits the pupils to examine, test, and study the specimen in a setting with proper equipment. Any object, whether it is animal, vegetable, or mineral, is only a fragment of the environment, however, when it is removed from its natural surroundings for purposes of study. It is important, therefore, to interpret the object in relation to its environment. Frogs, rocks and minerals, marine shells, or a feather from a bird, for example, may provide rich opportunity for science learning when they are carefully observed and given the necessary interpretation.

Charts may be useful in helping children arrange certain data concisely and clearly. An interesting time chart of the earth and the life upon it can be found in most science books. Such a chart presents quickly information which may require several pages of text for description. Charts may also be used in illustrating experiments children perform to compare results of compiled data. Graphs help to enliven statistical data and, when applied to science activities, they

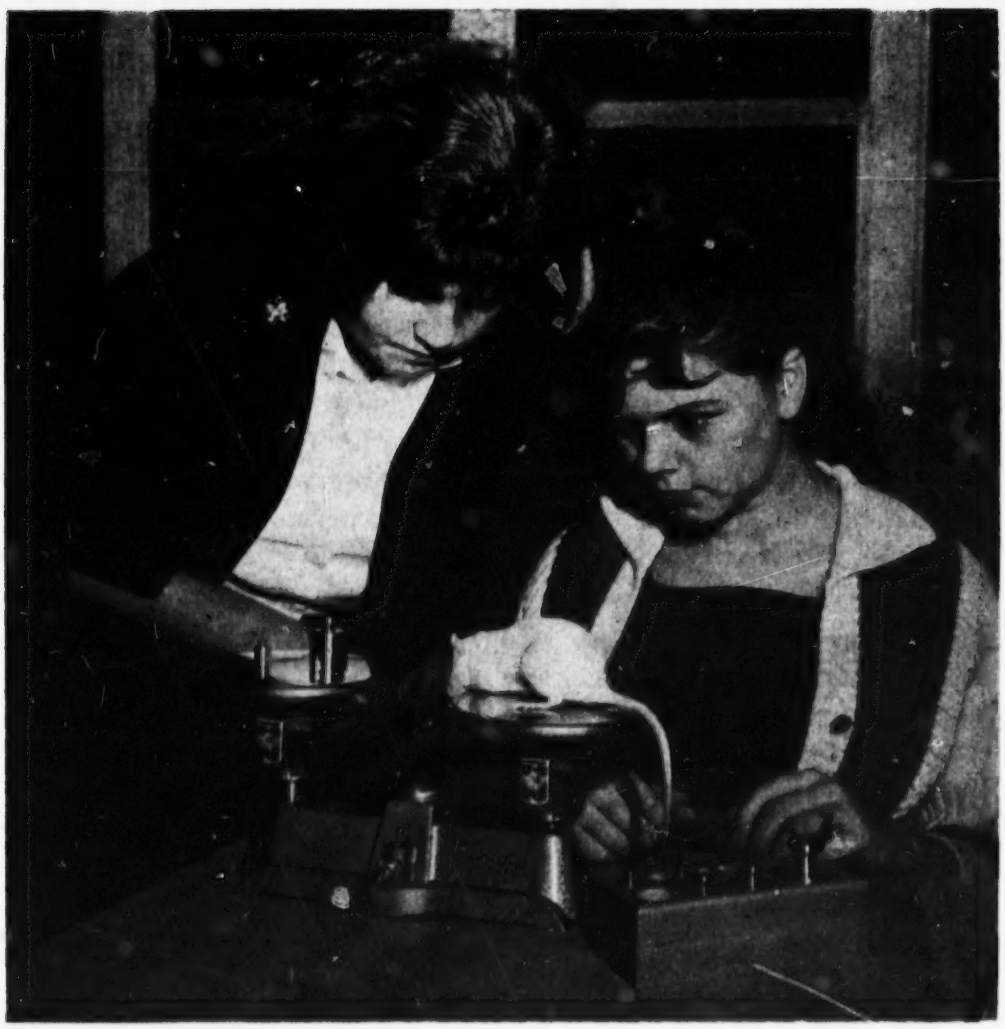
help make clear certain arithmetical concepts. For example, in a fifth-grade experiment to show how different diets affect young rats, a bar graph was prepared by the pupils, using the data collected on the growth and weights of the animals. The graph clearly illustrated the results of their experimentation and also provided the children with experience in using the language of graphs.

The value of direct purposeful experience in science for children is well recognized, but since a school program imposes various limitations on offerings, there is also a place for contrived experiences. For example, direct experience with a jet aircraft at an air terminal will not of itself provide a group of children with an understanding of how a jet aircraft functions. The more important aspects of flight could be learned through some other teaching procedure. The same may be true of trying to provide direct experience with atoms and molecules which are too small to be seen and too abstract.

It sometimes becomes necessary to contrive experiences in order to give reality greater meaning. Models, specimens, objects, and mockups are examples of aids which are used extensively by the elementary teacher to explain science phenomena. A model of a water-purification system enables a child to observe carefully each process in the whole operation. Individual units may be dismantled and examined minutely and, thus, functions become clearer. A mockup of a simple circuit, prepared by a teacher or pupils, can illustrate in a unified fashion the various elements of circuitry. Complete, incomplete, open, closed, and short circuits can easily be demonstrated in this way.

Courtesy, Detroit Public Schools, Detroit, Mich.

Science fair exhibits reflect a variety of interests.



Courtesy, Mount Eden School District, Hayward, Calif.

Using a balance and weight set to discover how different diets affect young rats.

A map can be a tool of enormous value to the pupils engaged in science study. Children may use maps to trace the migratory routes of birds or to follow the major current system of the North Atlantic Ocean. Various terrain and geological formations can be identified on certain types of maps. Weather maps are almost essential in studying climatology or weather and are frequently used by pupils in learning how weather conditions are forecast. Appreciation of the work of the meteorologist is enhanced when a boy or girl understands how much data is needed to make a weather map. There is also a variety of star and space maps which can be used in exploring the heavens.

The globe, in addition to its geographical value, enables the pupils to study land masses, discover distances over great circle routes, see relationships between the polar regions and air routes in transconti-

nental travel. It has become almost standard equipment for discussion of seasons of the year, solar and lunar eclipses, and explanations of day and night when it is used in conjunction with other audio-visual materials. Some globes are made of plastic material which may be inflated; others have a metal component which can be used with small magnets. Many have specialized uses in astronomy studies. An orrery is a type of globe which shows the position of the planets in relation to the sun. Some orreries are designed to show this by the month of the year. Celestial globes are star finders and maps of the heavens and present the basics of astronomy. Moonballs are reproductions in three dimensional relief of the moon as it is viewed from the earth. The surface features are generally identified.

Planetariums, which may be purchased in varying sizes and quality, project stars and constellations upon the wall or ceiling of a room. To obtain some measure of accuracy in projection, a domed ceiling is required. There are a variety of solar and lunar devices which enable the teacher and pupil to demonstrate sky phenomena.

In many places television provides the only science program in the school. The followup of the TV program by the classroom teacher determines the kind and amount of laboratory experience that children receive. The TV teacher should always be a thoroughly competent, skilled, and inspirational teacher, fully trained for TV teaching

Courtesy, Mount Eden School District, Hayward, Calif.

Models aid pupils better to see relationships.

and provided with tried and tested program material. This "on-camera" teacher should also work closely with the classroom teacher in developing the program and should receive "feedback" of information to strengthen the telecasts.

In many parts of the country, educational television has become a powerful medium for shaping the science program, and a great deal of experimentation is in progress. As a new medium it requires constant evaluation. TV should not be used as a total program any more than any single instructional aid should constitute a total program.

Teaching machines and related devices are presently undergoing extensive evaluation in many areas of the curriculum, including science. Since machine teaching is done by a program of instructional materials, major assessment focuses on the quality of program. Like other educational media utilized in elementary science, self-instructional programs need to be examined on the basis of what the pupils are expected to do and whether the pupils are attaining the goals of the science program. Science instruction with tutorial machines, just as with textbooks or other aids, requires the planning of integrated laboratory experience.

Industrial and Commercial Materials

The list of industrial firms that distribute free and inexpensive materials to teachers is voluminous. Quantities of these materials may be obtained by writing directly to the organizations concerned. Many firms employ the professional services of experienced educators for the purpose of developing this type of material. Many State and Federal agencies also distribute helpful materials and frequently issue catalogues containing annotated items. Materials might include pamphlets, books, an array of printed matter, pictures, maps and charts, a variety of films, filmstrips, phonograph records, industrial samples of raw and processed materials, and elaborate exhibits.

In selecting commercial material of any kind, the teacher should be certain that the material is adaptable to the program. A few criteria used in selection might help to screen out the undesirable aids:

Is the advertising motive more obvious than the instructional value?
Is material accurate, exaggerated, or biased?
Does it fit the intent of the school program?
Does it have a specific use in the classroom?
Is it appropriate for the maturity of the learner?

The space-age industry has ushered in a host of new materials. Excellent maps, charts, and pictures of up-to-date materials on space explorations may contain more recent information than textbooks

because of the rapid technological advances in the field. Perhaps the most desirable features of much of the information supplied by non-government and government agencies are the detailed accounts of a particular industry, process, or product.

Selecting Equipment and Materials for a Science Program

IN LEARNING SCIENCE, children plan, discuss, read, report, and listen, but these alone do not add up to effective science teaching. The vital elements are experimentation and demonstration.

Equipment in Relation to Program

What is to be taught in a science program and how it is to be taught should determine the equipment and material needs. It would be untenable to purchase a model of a power dam, a science kit, or some object and then build a program around it. If children are to assemble or construct instruments for a weather station, the purpose of the instruction should determine what will be purchased and what will be constructed. For example, a barometer or thermometer may need to be purchased, but a weather vane may be constructed. In each instance the value to the learner should be considered.

Complicated materials and apparatus are usually not suitable for elementary school children, since they may confuse the child and sometimes actually interfere with the principle to be taught. Concepts developed with formal, complex laboratory equipment are often isolated thoughts in the mind of the child. Ideally, most demonstrations or experiments should be such that they can be repeated, varied, or extended at home.

The grade level, the geographical location, the textbook or the science guide or manual, availability of utilities in the classroom, and the ingenuity of the teacher are some of the factors which determine the materials and the equipment needs for a given classroom. Also, equipment which might be suitable for individual or small-group experimentation might be too small to be seen easily if used for demonstration purposes. Thus, content and method are factors which bear directly on the needed materials.

Since careful observation is an important aspect of science learning, much valuable experience may be gained by simply viewing the natural environment either in the immediate vicinity of the school or on an extended field trip in which ecological relationships are sought. Often observations which children make of the day and the night sky,

Courtesy, Detroit Public Schools, Detroit, Mich.

Simple, low-cost equipment often aids science learning.

of natural habitats of plants and animals, and of land and rock formations require no equipment or materials but result in considerable learning.

The teacher as well as the children can be alert to science materials in the environment. Collections of materials, besides being useful in study, may often lead to careers, hobbies, and leisure-time activities. Children may sometimes be encouraged to bring to school specimens from the out-of-doors or articles from home. It is natural for a youngster to bring a cocoon, a new toy, or a budding twig to school to "show and tell." This becomes a resource for the teacher and a stimulus to learning. A personal contribution helps the child to identify more closely with the project and to develop self-direction and resourcefulness. However, too much dependence by the teacher on the contribution of the children is impractical, since responses are often capricious. The practice of engaging children in participation by having them contribute material or construct apparatus should in no way replace the use of essential equipment and materials provided through the school budget.

Projection Equipment and Materials

Motion picture and filmstrip projectors have become almost standard equipment for most elementary schools and, in general, are ac-

Courtesy, Detroit Public Schools, Detroit, Mich.

Youngsters like to "show and tell."

cessible to teachers. For easy handling, many projectors are mounted on mobile carts which can be moved to the room where they are to be used. Classrooms are either equipped with projection screens and darkening facilities or special rooms are equipped and designated as projection rooms. With the greater availability of motion picture films on elementary school science and with funds for purchase being greatly increased, the use of films is becoming more widespread. The quality of films is constantly improving and they are geared more and more to the instructional program. Science films for elementary school children deal with subject matter that emphasizes, to some degree, the process and the application of scientific principles, as well as the products of science. Films that emphasize the products of science are oriented to the social studies and center around themes of transportation, communication, and devices which have made life easier in the home.

Filmstrips (or slidefilms) are usually 35 mm. in width and often present a sequence of still pictures on a specific area in science. The teacher may use all or a portion of the sequence. Sometimes individual frames from a filmstrip are used for instruction. Synchronized recordings of commentary can be used to create a "sound filmstrip."

There is a great versatility in the use of slides, since the teacher can do his own photography and make or procure a slide for almost any subject. Slides may also be used with sound accompaniment—mainly from record discs or tape recordings. Bird calls and various animal sounds have been effectively used with picture projection. Many teachers make a hobby of taking their own slides in color.

Microscopes have many uses in elementary classrooms. Magnifying a specimen in science often helps the teacher get across an idea which may not be in evidence when the specimen is viewed macroscopically. However, it is important with children not to use so high a power of magnification as to make the part which is enlarged seem totally unrelated to the whole specimen being examined. Even if the teacher helps the pupil properly focus and adjust the microscope for viewing, he is not always certain that he will see what is actually on the slide or even the section of a slide that needs to be observed for study.

Courtesy, East Atlanta Schools, Atlanta, Ga.

Motion pictures in science help bring reality closer to children.

Courtesy, Mount Eden School District, Hayward, Calif.

Microscopes have a variety of uses in elementary classrooms.

The problem is even greater with live and moving material. Microprojectors have some advantages in this respect. Although microprojectors are usually limited in magnification compared to some microscopes, the enlargement in projection will generally suffice for most elementary school children. While a microscope can be used by one person at a time, the microprojector projects the object or specimen on the screen so that the entire group can see it. This enables pupils to discuss the material shown on the screen and helps the teacher to clear up certain points for the entire class. In addition, each individual has the same focus on the image at the same time. This may be useful in certain instances.

Since an opaque projector can project on a screen nontransparent pictures, flat specimens, and even shallow containers, its possibilities for elementary science are manifold. Photographic and hand-drawn or hand-written illustrations are commonly used. In addition, botanical and animal specimens of some types can easily be projected. Opaque projectors can be used for children in almost all grades. Some specimens too fragile to be passed around for individual examination can be projected for an entire class. Children also can prepare material for projection.

Overhead transparency projectors have a distinct advantage in elementary science classes because the teacher can face the pupils in front of the class when projecting the material. The teacher can also draw or write on a plastic sheet in the course of his presentation with an overhead projector. The chalkboard may be comparatively limited in this respect, since a greater number of pupils can readily view an overhead projection with ease. Much of the material used can be prepared by teacher and pupil, using various colored wax pencils for color if desired. With successive layers of transparencies or overlays, various stages in a scientific process may be illustrated or changes which occur in a life science sequence shown dramatically.

As projective techniques and materials are developed further, their place in instruction must be constantly evaluated by both teachers and administrators. It is well to keep in mind that projective techniques are used mainly with groups of children, whereas nonprojective techniques are more for individual use. Both types have their place in a good science program.

Kits, Carts, and Package Materials

Science kits and so-called "packaged science" are of particular concern to program builders because of their popularity and their potential misuse. The busy administrator who lacks the time to select and order separate items from the various catalogues looks upon the kit as a solution to his program and equipment problems. Likewise the teacher who is inexperienced in building a science curriculum welcomes the readymade program. Although the cost of some kits may exceed that of the same items purchased separately, the kits do contain useful materials. Some supervisors of science, however, have emphasized that an overdependence on science kits may have a limiting effect on an instructional program. This equipment, like other types of equipment, can be used effectively or ineffectively. Some persons are concerned with the stereotyped use of equipment, leading to the so-called "cookbook" science. To a large extent the kit may determine the program.

The several commercial kits familiar to most teachers and available in elementary schools have quite a range of price depending on the amount and quality of the contents. They contain a variety of physical science items, such as magnets, spring-balance, thermometer, and magnifier. They are usually marketed in specially built boxes with handles, which makes them convenient to carry.

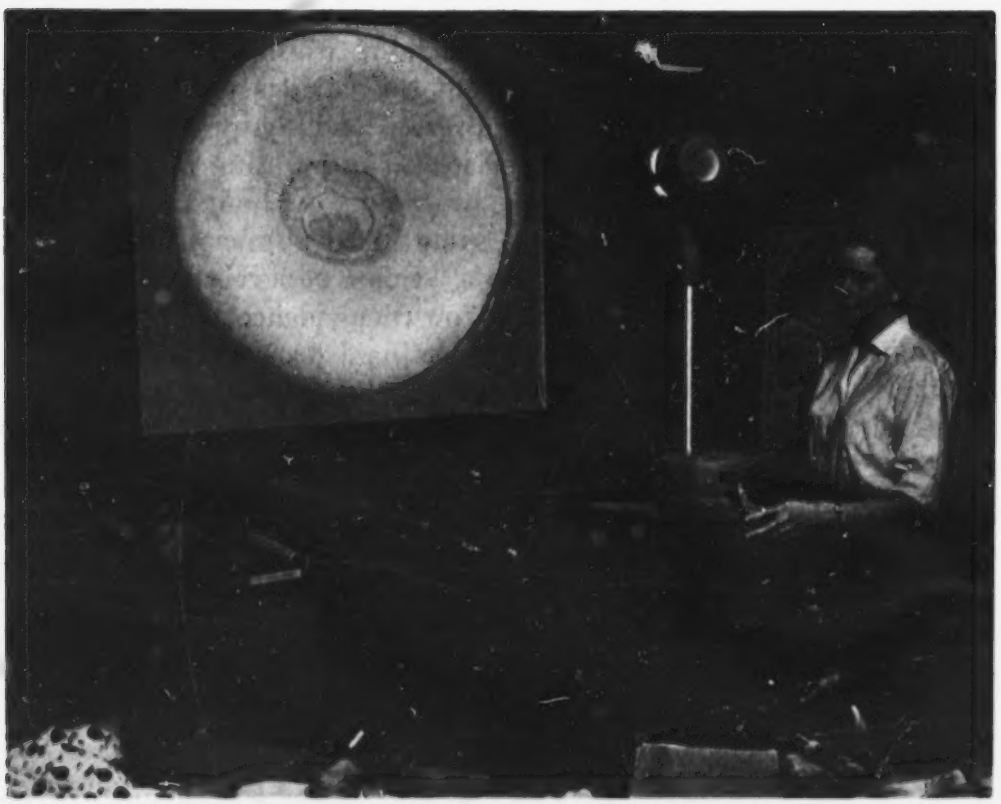
Some schools or school systems make their own kits; they construct the box and obtain the materials for it from many sources. One type of school-built kit is designed to provide materials for the study of

concepts in a specific unit or area in elementary science, such as earth science, the night sky, light, heat, sound, magnets, and weather. In some school systems these kits are called "shoebox kits"; in other places they are called "science-concept boxes."

Some kits emphasize the assembly of a particular kind of equipment, such as a toy motor, telegraph set, question-and-answer boards, or optical system. The skills developed in putting the component parts together would justify the activity, providing the purpose of the activity is clear at the outset.

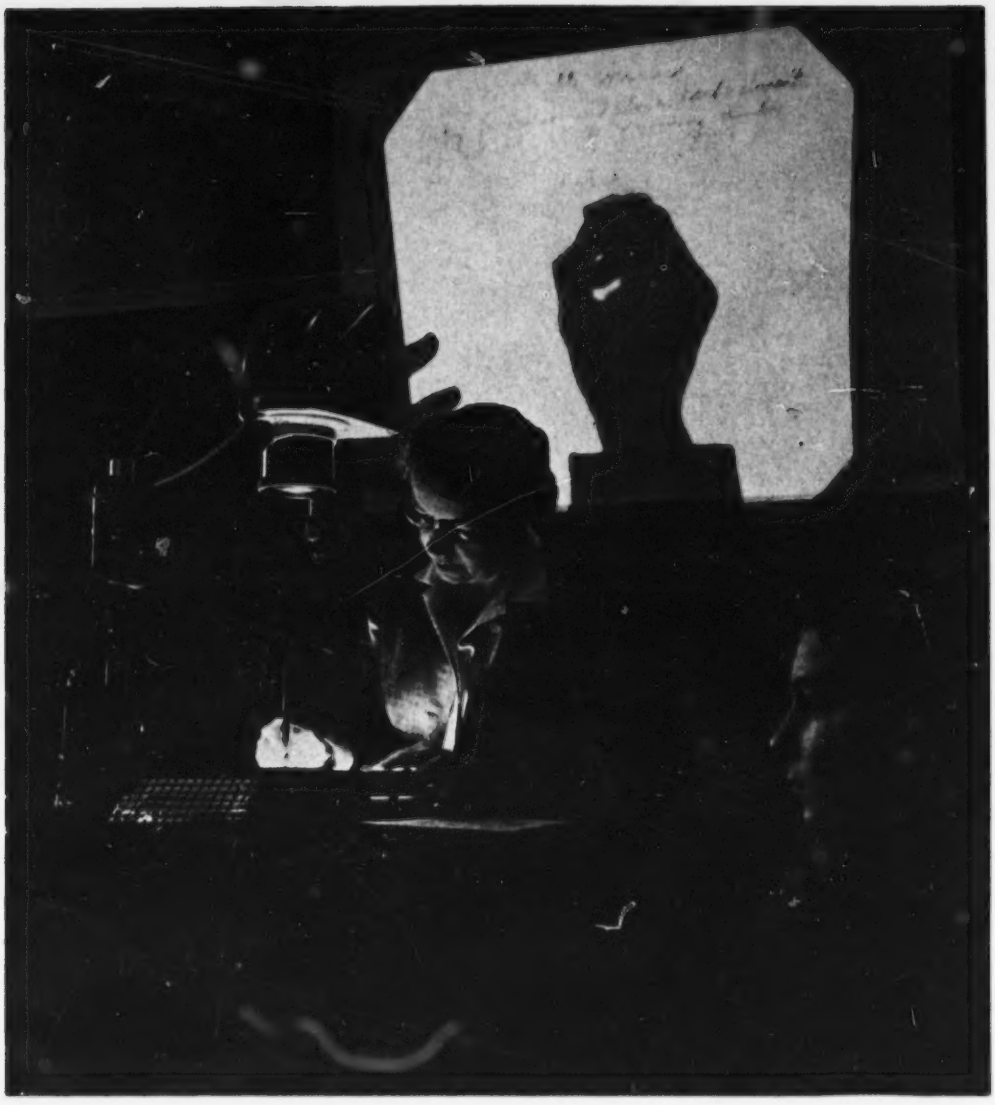
To relieve the problem of storing and transporting materials and equipment, a cart or mobile arrangement has been made available to teachers in various school systems. Some carts have been constructed in local mill shops; others have been built by school personnel. The cart usually contains basic science materials, both commercial and improvised, arranged in an orderly fashion. Much of the material is contained in boxes or in compartments, according to topics, and is labeled and inventoried. Some mobile units contain a source of water and a source for heat, and can be moved from classroom to classroom.

There are currently available several commercially designed labora-



Courtesy, East Atlanta Schools, Atlanta, Ga.

Microprojectors enable an entire class to view a microscopic specimen.



Courtesy, District of Columbia Public Schools, Washington, D. C.

The teacher faces her pupils when she uses an overhead projector.

tory units for use in elementary schools. Much like the handmade cart, they are more elaborate in construction and are intended to provide the laboratory facilities which many elementary classrooms lack. They come in a wide range of prices, depending on construction, features, and size. In the opinion of many school people these carts have solved, in part, some of the problems of work space, utilities, availability of demonstration equipment when needed, and mobility of use.

The Place of Commercial and Improvised Equipment

There is clearly a place in the science program for both commercial and improvised equipment. The value of each for its contribution to

Courtesy, Westside Elementary School, DeWitt, Ark.

Mobile science unit provides equipment wherever needed.

the educational process must be studied carefully, and the determination to purchase or improvise can then be made in relation to program needs and the purposes to be achieved in the learning activities.

In many areas of science study there are a number of satisfactory ways to demonstrate the same principle. To show the effects of air pressure, for example, the teacher may use either an elaborate vacuum pump or the classical "egg in bottle" demonstration. Each can show the effects of reduced or increased pressure. If resources are plentiful, a variety of experiments may be used. To reinforce learning and stimulate critical thinking, children should be challenged to devise their own methods of illustrating principles and experimenting.

To avoid frustration, all projects for construction should be carefully considered in terms of the children's ability and the availability of tools and materials. Adequate raw materials, tools, and work space are essential. If small-group experimentation is to be encouraged, equipment should be sufficient to allow all children to participate.

In a successful activity in which a model of a solar system was contrived, children used numerous references for information, many

aids, creativity in mounting, and arithmetical concepts in measuring distances and making models to scale. They soon learned the limitations of the models but were stimulated to learn more about the night sky and achieved great appreciation of telescopes and optical equipment. If in construction of equipment a child is helped to better understand a science concept or can better apply a principle of science, then the activity is warranted.

In the past, because science and equipment facilities were often inadequate, teacher education emphasized skills designed to develop resourcefulness in borrowing, salvaging, and improvising materials and equipment to provide low-cost aids for teaching science. As a result, valuable teaching time and effort often were spent in the creation of makeshift facilities. As greater amounts of equipment and materials become available, more instruction can be done with commercial scientific equipment. Elementary school pupils may continue to build thermometers so that they may better understand the principles of temperature and measurement, but they will need precision thermometers for exact readings of temperature. Simple materials from the child's environment can provide rich learning experiences, but dry cells, wire, meters, and other apparatus cannot all be improvised. The child who constructs a telegraph set or miniature motor from metal, wood scraps, wire and nails, learns about ma-

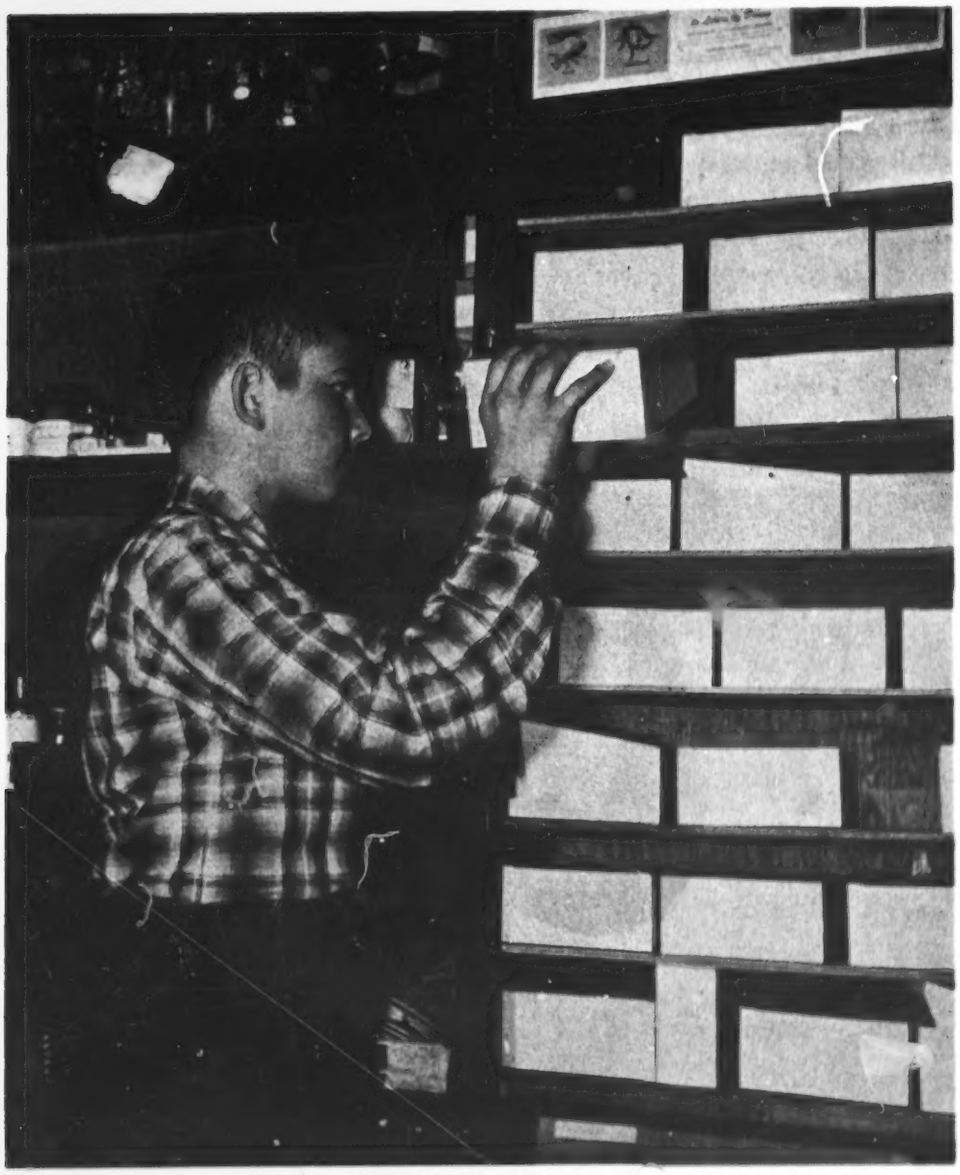
Courtesy, Springfield Public Schools, Springfield, Mo.

Proper equipment gives opportunity for life science study.

terials, electromagnets, and principles of rotation. He also exercises manipulative skill in the activity. The commercial motor, however, gives him opportunity to study construction and, further, to explore the operation that makes motors useful.

Organization, Storage, and Distribution of Equipment

To insure adequate classroom control during periods of class activity, the teacher will need to work out a plan for distributing and collecting materials. Frequently used items should have storage



Courtesy, Elizabeth Van Auken School, Palo Alto, Calif.

Good storage space encourages science activities.

facilities close at hand. When a classroom is being designed to include adequate storage, consideration should be given to the characteristics of each item, such as kind, quantity, size, shape, durability, and frequency of use, and, then, the storage facilities planned accordingly. Storage appropriate for chemicals differs from that necessary for telescopes, microscopes, large charts, or demonstration apparatus. Delicate or expensive equipment which requires special handling, such as galvanometers or microscopes, should be kept under lock and key. Chemicals should also be stored some distance from any equipment that will corrode.

Some costly equipment items which are used infrequently might be stored in a central location either in a school building or central warehouse or in a cooperating children's museum, materials center, curriculum laboratory, or audiovisual center. Much will depend on the facilities available in the school system. If items are distributed to classrooms from a central supply room in a building, a system of classification, labeling, and inventory will help in locating and distributing them.

Whether equipment is stored in a school building or at an instruction center, it is important that an easy method be devised of making it available to teachers if frequent use of the item is desired. Some provision also should be made for repair and replacement of materials and equipment.

Orienting Teachers to the Purpose and Use of Equipment and Materials

Inservice Meetings and Equipment Committees

Teachers who are inexperienced in teaching science and who are vague about a science program cannot very well make judgments on which equipment is appropriate for children. The inservice education of staff in the use of equipment may require a series of meetings primarily designed to help evolve a common philosophy of science teaching and to insure that each teacher recognizes the significance and role of science teaching in the elementary school program. Even when a guide or course of study is available, teachers may lack confidence or the experience to use it to full advantage. It is then that an individual who is well trained and experienced in both science and education and recognized for his successful teaching in elementary science should be brought in to serve the group. He may be a science supervisor or consultant or an administrator working at the local or State level. He may be an instructor from a college or university or he may be a successful classroom teacher.

The most successful science workshops for elementary teachers have been those in which teachers work on a practical level and can relate the experience to their own classroom situations. The teachers gain confidence when they are given the opportunity to handle equipment and materials, engage in activities which are like those the children will enter into, and perform experiments and demonstrations much like those envisioned for the classroom. Where workshop instruction is simulated to conform as closely as possible to the active classroom conditions, teachers seem to gain most from the experience.

Television is also being used for inservice improvement in science teaching. One large school system in the East has regular programs of instruction in which teachers learn to construct teaching aids for the classroom. It is a "doing" program with direction coming through TV receivers throughout the city school system.

In any inservice program in science, the use of committees can involve large numbers of teachers, who, because of their participation, feel more a part of the program. Some teachers feel that those who serve on committees, devoting time to professional business,

Courtesy, Office of the Superintendent of Public Instruction, State of Ill.
Workshops offer important science experience for teachers.

should be allowed some release of time during the day to work on these duties.

Committees can function in a variety of ways. They study program needs and suggest supplies and equipment which implement the science program and improve classroom conditions. Equipment committees keep informed about the newer developments in the equipment field and help to revise existing standards as improved products appear. They also search for better ways of utilizing equipment and frequently plan inservice programs to effect this. They are cognizant of teachers' needs and recommend items which help strengthen teacher practices.

Some committees are charged with examining and helping to select textbooks and preview films, working on study guides and curriculum improvement, and preparing lists to help the teachers locate human and natural resources. Committees may also work on facility prob-

lems that may be hampering the science program; encourage the exchange of ideas among teachers; plan science fairs, exhibits, and library resources; and bring to the school selected pamphlets, guides, and other published materials. Committees may work on building-, grade-, and system-wide levels depending on their particular task and sphere of influence.

Visits to a school where a teacher is using equipment in teaching situations should be encouraged. More and better science teaching is stimulated where opportunity is given for teachers to pool and share ideas and practices.

Materials Centers

Instructional materials centers have been useful inservice aids in many States. Sometimes the centers are merely idea rooms where teachers can examine materials and models; view bulletin boards, dioramas, cycloramas, display tables; and generally avail themselves

Courtesy, Office of the Superintendent of Public Instruction, State of Ill.

Teachers construct instructional aids at the materials center.

of printed material which may suggest the use of aids and materials in selected activities. Usually the materials contained in these centers include tools, building materials, equipment, reference books, standardized tests, catalogs, films, and audiovisual equipment. Many centers make provisions for teachers to construct instructional aids at the centers for use in the classroom. The center is often used as a central point for the distribution of equipment and supplies. In many instances, the instructional center becomes the meeting place for teachers gathering for institutes and general conferences on program improvement in elementary science.

Mobile Science Laboratories

A mobile science laboratory has been operated in one of the most sparsely populated States. The 32-foot trailer is a laboratory on wheels, designed to assist elementary school teachers in the use of equipment and materials. It contains a 12-station science laboratory and travels from area to area for a prescribed period of time. Its program is geared to help teachers develop efficiency in using equipment and introducing new materials, as well as in developing a sense of creativity. The mobile science laboratory is set up in a school yard for a 3-day session, three times during the year. The elementary teachers who sign up for the first meeting continue through the year until a total of 27 hours of inservice instruction is acquired by each. The first 3-day session covers natural sciences at the elementary level; the second and third sessions cover the physical sciences in the elementary school.

Local districts participated in this program by providing released time for the teachers; the electricity, water, and sewage facilities that were necessary to tie in with the laboratory; and drivers to transfer the trailer from area to area. In addition to the equipment necessary for performing experiments, the mobile laboratory contains a curriculum and reference library on science and a collection of basic audiovisual aids designed to serve as part of the inservice education program.

Helpmobile and Drive-in Conferences

Various techniques have been used by supervisory personnel to bring teachers together for programs designed to promote better utilization of materials and equipment. Often a classroom in a centrally located school will be used for institute or conference workshops, at which time practical demonstrations illustrate uses of equipment. These conferences are generally described as helpmobile or drive-in conferences.

School Policies Regarding Use of Science Equipment

SAFETY in the use of equipment and materials in science study should be of foremost concern to the teacher and pupil. An accident may undo all the work a teacher has done to develop a science program. In the aftermath of careless activity, some schools have prohibited the use of lighted candles or open flame in a classroom; others have outlawed the use of certain laboratory animals in a school; and, in one county, field trips are seldom encouraged because teachers fear liability suits.

At the opposite extreme, some schools adopt a laissez-faire policy until some misfortune occurs. Some preventive accident measures incorporated in written policy would do much to encourage greater confidence in a good science program. It is common for school systems to issue to teachers and administrators handbooks on safety.

Safety Regulations in Planning Equipment Needs

Just as good housekeeping will prevent accidents in the home, so it will reduce hazards in the classroom. A practical "common sense" approach to building safety habits with children as early as the primary grades will go far toward guarding their future security.

Many safe practices become almost automatic with children who have had planned science experiences. Understandings developed from careful observation, experimentation, demonstration, and study will aid the child in exercising caution when confronted with a natural or industrial hazard. The science room should provide opportunity for youngsters to practice safegurads and to overcome fears.

Children should learn that materials that may cause slipping or tripping must be removed from the floor immediately. They must be taught not to place foreign objects in their mouths, ears, eyes, or nose. It is not uncommon to find children placing chalk, marbles, buttons, and similar objects in their mouths. Careless use of sharp and pointed objects, such as scissors, pointers, and pins, often result in injury to children. Pupils should be made to realize certain dangers and should be instructed in the proper use and care of all equipment and materials.

Throughout their lives children will lift many heavy things. Therefore the teacher should take the opportunities in the classroom

to teach the correct manner of lifting and of relating it to science principles. Aquariums and terrariums, because of their weight and construction, are particularly heavy. Aquariums should be emptied with a siphon or dipper before moving. Since the lifting power varies from person to person, a teacher should use judgment in ascertaining the relative weights that pupils might be required to lift.

All glassware should be subject to special regulations when handled in cleaning, moving, or demonstrating. In many school systems, teachers are cautioned against permitting immature pupils to use such items as bottles, vases, jars, and pitchers. It has been suggested that paper, metal, or plastic receptacles, which are less fragile than glass, be used by children in early elementary grades to carry science materials into school. However, if the teacher cautions children about the hazards of handling glass and provides some supervision to insure against careless practice, accidents can be held to a minimum.

Elementary school programs often provide opportunity through gardening activities for the study of plant life. The learning of good garden practice should begin with primary children. The teacher and class should discuss the safe way to carry and store tools.

Courtesy, Pitcher School, Detroit, Mich.

Gardening activities create interest in plant life.

When a child places a hoe, rake, or weeder on the ground, he must learn to place the teeth or sharp edges so they will not injure anyone. Some insecticides, fungicides, and weed killers are poisons and should be properly labeled and used only under the direct supervision of the teacher. Children should be taught to use care in handling cacti and plants with thorns and burs because of the possibility of injury. Also, conservatories should always be kept free of clutter. Supplies, such as flats, flower pots, and water hose should be kept in orderly arrangement.

The extensive use of electricity in home and school places a grave responsibility on the teacher to exercise special care in handling electrical equipment and materials. All electric wiring should be scrutinized regularly for exposed places where accidental contact might cause injury or where short circuits might spark fires. Many building codes prohibit temporary wiring when the electrical device is to be used continuously at one location and also require that drop cords be used only as temporary expedients and never extended through windows, door frames, or other places where friction might cause a short circuit. Connecting cords should be short and plugged at the nearest outlet.

Whenever any new electrical device which is not in common use in schools is to be used, caution should be exercised and official sanction secured from proper authority.

Electric plates are commonly used in elementary schools as a prime source for heat in conducting demonstrations. An electric plate that is being used should rest on an asbestos pad or some other fireproof material. There may be occasions when it is necessary to place an asbestos pad beside it for hot materials. It is good practice to disconnect electric equipment when it is not in use. This rule applies to stoves, heaters, water heaters, and furnaces of all kinds. Before leaving the room at the end of the day, the teacher must take particular care to disconnect all electrical equipment.

Since tap water is a conductor of electrical current, children should be instructed never to touch an electric cord, switch, or appliance with wet hands nor to use a damp cloth to clean the outside of an electric plate while it is turned on. If wet cleaning is necessary, disconnect the hot plate and wait until it cools. Although dry cells have low voltage and are quite safe in ordinary use, children should be cautioned to avoid crossing bare wires to the terminals of a new cell, since a burn may result.

Every turn of the seasons affords special occasions for planning activities for the children around particular holidays. For example, Christmas is a good time to plan for certain science activities. In-

Courtesy, Wichita Public Schools, Wichita, Kans.

Principles of science can be illustrated with simple apparatus that is safe and effective for demonstration.

vestigating the origin of Christmas plants will help children better understand history, customs, and superstitions as they relate to plant life. Working intimately with nature materials will involve them more directly with the ecology of living things. However, Christmas trees, cones, berries, and evergreen scraps brought into the classroom increase the hazard of fire. One school system circulates a bulletin, as the holiday season approaches, listing safety precautions to be observed in setting up Christmas trees and working with evergreen materials.

Field Trips and Excursions

Field trips or excursions may provide some of the most stimulating learning activity in science They afford the pupils an opportunity for direct observation and a view of plant and animal ecology impossible in a classroom situation. Field trips, excursions, and walks will also provide opportunities to practice safeguards previously learned in the classroom. Trips should be planned with this in mind.

The practice of good hygiene is important at all times. The bite of an insect may not be as harmful as the subsequent scratching which irritates, breaks the skin, and causes infection. Girls and boys,

having learned about the role of bacteria in diseases, can be cautioned to avoid drinking or wading in polluted waters.

Equipment for collecting specimens should be safe and suitable at all times. The use of cyanide jars is prohibited in many elementary schools, but some chlorinated hydrocarbon such as trichlorethylene or perchlorethylene may be used to kill insects. Some insecticides are also effective for this purpose.

Baby turtles make good classroom animals and are easily managed, but snapping turtles have hard cutting jaws which inflict severe bites. When collecting turtles, frogs, or toads, a youngster should be on the alert for snapping turtles.

Children should be taught to recognize poison ivy and poison sumac so that they may avoid them. Teachers should always be familiar with first aid treatment. Children should be cautioned about placing any parts of plants in their mouths. When cooking outdoors, they should avoid placing food on the branches of oleanders or other poisonous plants. Since edible field mushrooms are difficult to identify, mushrooms should be used only for making spore prints or in exhibits and not as food. A child should learn to stay away from all animals which are known to be unfriendly, all plants which may be harmful, and any area which presents dangers.

Courtesy, Palo Alto Public Schools, Palo Alto, Calif.

Dry cells are useful in learning about electricity.

Courtesy, Wichita Public Schools, Wichita, Kans.

Live animals provide motivation for science experience but require special care in the classroom.

General Suggestions

Since there is great value in keeping living things in the classroom for purposes of instruction, simple suggestions on proper treatment and care of animals will be helpful to teachers.

All animals in classrooms should be kept in adequate cages or vivaria from which they cannot escape.

Cold-blooded animals kept in the classroom for purposes of instruction must have excellent care and show evidence of responding to an indoor environment; otherwise, the animals should be released to their natural habitat.

Warm-blooded animals may also be kept in the classroom but always under proper sanitary conditions and the most careful maintenance. It is not wise to keep such animals as monkeys and parakeets in the classroom for long periods of time because they may be carriers of certain contagious diseases. Animals capable of inflicting venomous bites, such as rattlesnakes, gila monsters, or blackwidow spiders, should be prohibited in the classroom or in school laboratories. Animal cages or containers should be so constructed as to prevent the possibility of the animals biting pupils. Whenever pos-

sible, doors to cages should be kept locked and the keys kept in the custody of the teachers. The fact that animal bites may result in infection or poisoning should be brought forcibly to the attention of the pupils.

Children should only be allowed to help care for animals and feed and generally maintain living things under the direct supervision of the teacher, and they should only handle the pets when there is evidence of instructional value to be derived from the experience. When it becomes necessary to handle a wild animal, gloves should be worn for protection, and after such an animal has served its purpose in a classroom, it should be liberated in its natural environment.

Budgetary and Procurement Practices

MOST ELEMENTARY SCHOOLS have some budgetary provisions for equipment and supplies. In only a few instances are funds earmarked specifically for science equipment, and in some situations where funds are not earmarked, they may be obtained from other allotments. In one small school system, instructional supplies of an expendable nature, plus the equipment, averaged $4 per pupil. Of that amount, actual science equipment purchased was so fragmentary it was not even considered. Science equipment was requisitioned from the central budget.

On the other hand, a large school system in the Midwest has a department of science and a budget which requires approval from the board of education. The equipment items are classified on special forms with a charge and identification number. The equipment lists have two main classifications, (1) new and additional equipment and (2) repair and replacement equipment, and funds are allocated accordingly. In each fiscal year, requisitions are prepared by the elementary school science teacher with the principal's approval, from extensive lists developed by equipment committees of teachers and supervisors. There is a general allocation of $60 to a science room for supplies but equipment allocations vary. The requisitions must be returned by a specified date to the central office where they are tallied, sent to the purchasing department, and, from there, sent out to bidders for purchase. When bids are returned, they are checked for specifications and charges. If incoming bids are equal in prices and value, the orders are divided among the bidders. In the system described, all coded items are sent to the warehouse for distribution. Those items that are not coded are delivered directly to schools.

In small school systems with no established policy, it is likely that purchases for science will adhere to the same procedures as for other areas of the curriculum. In most school systems, requisitions for purchases are prepared in the early spring for the succeeding year. Where no established lists determine the type of purchase or where extensive lists allow for great freedom of purchase, the teacher has a responsibility (which she usually shares with the principal) to suggest items consistent with program. The final decision usually rests with the principal of a school, who determines the amount that

may be spent, based on the budget, and transmits the request to the central office. After all requisitions from the schools are gathered in the central office, the business manager may either submit for bid or contact the vendor to contract with the systems directly. Large-scale centralized purchasing reduces the cost of items and provides for greater quality control.

Many rural schools authorize the teacher to buy a few essential items on a reimbursable basis, but there is much variation in practice. Teachers' requests are generally granted in proportion to the financial resources of the district.

In a decentralized system, the responsibility for allocation, requisition, and accounting is shared by individual schools.

Although accounting procedures in large school systems make it difficult to administer petty cash accounts for immediate purchase, such accounts are a great help to the teachers developing programs of science. Purchases which can contribute greatly to good teaching but which are not provided for in the regular budget may become necessary as a result of unexpected developments in the classroom. The need for incidental materials, perishable items, and certain living specimens, such as fish, meal worms, and plants, cannot always be anticipated. A point of frustration for the teacher is reached when he cannot obtain petty cash funds at a time when he needs them most.

Often science consultants or supervisors, who are employed in a school system and working with teachers, render help on problems of selection and purchase. Ideally, school personnel should be familiar with the program and equipment, supplies, and materials. Catalogs and available guides can provide much information on instructional materials for science.

Efficient purchase procedures, however, require the supervisor to develop specifications for items of purchase or to adopt specifications already worked out for items which have proved satisfactory. There are many sources of reliable specifications for items that may be considered for acquisition. The sample, on page 45, of an equipment item taken from a purchase guide [1] illustrates how specific descriptions may be provided.

It is clear from the entry that this construction characteristics as well as descriptions of other unique features make up the specifications for the spring balance. The specifications for items listed in scientific supply company catalogs should be compared with the

[1] From "Subject Lists of Equipment," *Purchase Guide for Programs in Science, Mathematics, Modern Foreign Languages* by Council of Chief State School Officers with the assistance of Educational Facilities Laboratories, Inc., National Science Foundation, and others. Boston: Ginn and Company, 1959.

0230
BALANCE, SPRING

ELEMENTARY SCIENCE • STANDARD, ONE FOR EACH 6 CLASSROOMS

GENERAL SCIENCE • BASIC, TWO FOR EACH CLASSROOM

PHYSICS • BASIC, ONE FOR EACH 2 STUDENTS

For ordinary low-load, noncritical weightings. This balance is alternate to dial-face type, Item 0240, and is particularly useful where both metric and avoirdupois measurements are desired. Balances with same general specifications but having different capacities are sometimes desirable.

Specifications: The spring balance shall be flat-face, of sturdy construction, carry both avoirdupois and metric scales up to 16 oz and 500 g respectively and be equipped with sharp pointer, ring and hook. The 500-g scale shall be graduated in 20-g divisions and the 16 oz scale shall be graduated in ½-oz divisions. The spacing of the graduations shall be large enough to be easily read. The scale plate shall be of nonmagnetic, corrosion resistant sheet metal and the spring housing shall be of sturdy metal or high impact plastic.

standards developed or adopted by the school system. Careful attention should be given to the precise descriptions of equipment items before submitting them for bids. Purchase on the basis of public bid is meaningless without accurate specifications. Also equipment standards should be continuously evaluated in the light of rapidly developing equipment technology.

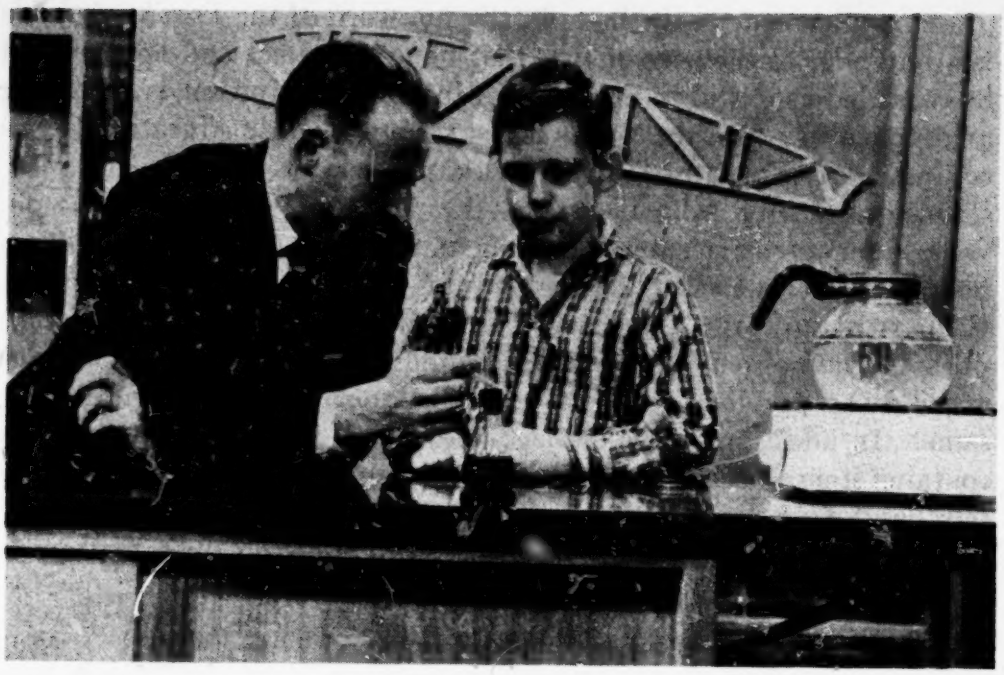
Types of Equipment Lists—Selected Samples

LISTS of suggested supplies and equipment reflect at best a general picture of the kind of instructional materials elementary schools may find useful in a science program. They are meant to be flexible and serve as a guide for those who use them.

In most published elementary science lists, equipment and supplies are usually combined and appear under selected subject titles. There is a great deal of variation in the listings, however, depending on the purpose for which the guide was developed. Lists are continuously being modified as new equipment becomes available. The use of lists implies that choices of items need to be made by teachers on the basis of the content of their subjects and methods of teaching. Since more than one item can often serve the same teaching purpose, it is important that careful evaluation be given each item in terms of its intended use. But in any case, a list should be determined by the program of instruction.

Many teachers rely heavily on the textbook to shape their science program, and it often becomes the mainstay of such a program. Activities, demonstrations, and experiments described in the text are performed with slight deviation. A tally is often made of the materials needed for the experiments and other activities, and this constitutes the list of materials for the program. This practice may be followed in places where adoption of a single text has been made. Many of the textbook publishers have prepared lists based on the simple activities suggested in the text. These lists often appear in the teacher's manual or printed supplement to the text and may be obtained on request from the publisher.

Many elementary schools use the multitext approach in teaching science. A variety of texts and supplementary, grade, and reference books of different reading levels are available for pupils. These are used as sources of information when the situation warrants it. Often, in this approach, provision is made for a curriculum guide or course of study which the teacher uses for direction. This guide is designed primarily to provide assistance in developing units of work for different grade levels, and it usually contains a section on resource materials. It also lists equipment and supplies which teachers may draw on for ideas. These science lists commonly become very extensive and are the basis for purchase of equipment and materials.



Courtesy, Detroit Public Schools, Detroit, Mich.

Experimentation and demonstration help develop scientific thinking.

Since the description of the equipment or supply item usually is limited to the name of the item on a list, it is essential that a knowledge of more specific descriptions be available for use by the individuals responsible for the elementary science procurement program. There is considerable variance in quality and cost of many manufactured items of the same type, and selection therefore should be made with this in mind. When an item appears on a list it should be assumed that specification standards have been worked out.

Because of budgetary limitations, it is often practical to make some distinction between basic or essential equipment, standard equipment, and advanced equipment. Recognizing this factor, the Council of Chief State School Officers prepared for all the 50 States, lists comprising three categories. (See appendix I.) The Basic Category includes items for a minimal program in science and itemizes the barest essentials. The Standard Category consists of items which, when added to the Basic items, give the pupil richer opportunity for learning. The Advanced Category consists of items which are not included in the Basic and Standard Categories and which are recommended for advanced work or for selected, specialized projects for students at all levels. Even though the items comprising the three lists appear adequate, it should be noted that the numbers accompanying each item have gaps in the listed sequence. These number gaps are intentional and suggest that additions conforming to specific pro-

grams can be made to the list. In the foreword of the *Purchase Guide* is a reminder to the user of lists that none is perfect and none should be regarded as closed in any way. Since new equipment is becoming available every day, the *Guide* is not designed to tie education to the equipment available in the year of its publication.

One large city school system—the Detroit Public Schools—developed an extensive subject list but limited each teacher's requisition by placing a monetary ceiling on the amount he could purchase. Each year, however, the teacher requisitioning equipment and supplies has an opportunity to select items which he may not have ordered the previous year, since the list remains fundamentally the same. In addition to the subject listing and name of item, the list contains item and code numbers which help to facilitate large scale purchase of materials. (See appendix II.)

By this system of classification, the following information is elicited:

1. Whether it is a supply or equipment item.
2. The level of school organization—elementary school, junior high school, senior high school.
3. Whether new and additional equipment or repair and replacement equipment.
4. Mode of distribution—direct delivery from company to schools, or delivery to board of education warehouse.

Another useful feature of this list is the inclusion of a separate column giving the unit of measure and mode of packaging. The suggested maximum quantity for each science room is listed and the unit price appears in the last column of each page.

The Detroit system adheres to a separate subject curriculum, sometimes referred to as a semidepartmentalized or platoon system, in which science is usually taught as a separate subject by a teacher specially trained to teach elementary science. In nearly all elementary schools, a classroom is designed and equipped for science learning. The organization and format of the list reflect this type of curricular organization.

One State educational agency—New York State Education Department—prepared a list of general nature and classified the items on it as equipment, supplies, environmental materials, and tools. Environmental materials constitute the largest category in this list and consist of nonscience items that are readily available locally from grocery, hardware, drug, Army surplus, or variety stores. (See appendix III.)

In this form the list serves primarily the rural population, but any school can extend the list as it wishes. Densely populated areas

having extensive science programs could develop more complex lists, using this one as a basis.

A national organization of science teachers—the National Science Teachers Association—aware of the need to familiarize elementary teachers with the use of science materials, devoted an issue of its publication to discussion of equipment, materials, and supplies relating to classroom teaching. Included in the report was a basic equipment list giving minimum material requirements for self-contained classrooms and identifying the place where materials are likely to be found, such as local store or science supply company, home, or school. (See appendix IV.)

The list is very general to allow individual school systems latitude in determining the details best suited to their own science programs.

One city school system—the Denver Public Schools—recognizing the needs of teachers in a particular locale, devised a list which names each item of equipment, illustrates it, and suggests some possible uses. Some of this equipment is most suitable at a particular grade level for a specific unit, but such a designation on the list does not limit the use of the equipment to that particular grade or unit. The columns for school inventories and storage may be used to expedite locating and obtaining the material in the building.

The list contains 137 items. The first 44 items are the minimum list that includes items which will be found in all elementary schools. Items 45 through 137 are materials which may be ordered by individual schools, following periodic survey to determine their needs. To show the format of this list, a few selected items appear in appendix V. These are not in the same order as they appear on the original list.

The lists described here illustrate different systems of classification which have been found useful in organizing science equipment and materials of instruction. Such lists offer convenient ways of keeping track of items that are needed by teachers in science programs. An examination of lists of various types may suggest to teachers, as well as supervisors and administrators, ways of developing a list which will be most suited to their own school program. A published list which closely conforms to the program may often be used as a basis or starting point for a school system's individual list.

When adopted lists are distributed, they may also serve to publicize equipment and materials and encourage their use. It is evident that lists may be devised by many different educational agencies and on different levels of organization—local, district and State. In each case they should be designed to meet their intended purpose. A State department list may by intent be quite general in scope in order to allow local systems leeway for more specific developments.

Entries on lists must always be accurate and developed in an easy-to-use format. They should reflect the best materials that can be found to help attain the teaching objectives. Items on a list should also conform to specifications designed to meet the standards of quality and function consistent with the science program. Science lists of approved and recommended instructional equipment should be under constant revision to keep them up to date.

Appendix I.— Basic, Standard, and Advanced List for Elementary Science[1]

Elementary Science: Basic

0085 Anemometer
0245 Balance, Spring, Heavy Duty
0300 Barometer, Aneroid
0370 Beaker, Griffin, Low Form
0385 Bell, Electric
0400 Binocular, 4x
0450 Boiler, Double
0615 Buzzer, Electric
0880 Clamps and Tongs
1015 Compass, Magnetic, 1.5 cm.
1020 Compass, Magnetic, 4.5 cm.
1390 Electromagnet, Horseshoe Form
1485 First-aid Cabinet, with Supplies
1510 Flask, Erlenmeyer
1520 Flask, Florence, Flat Bottom
1805 Globe, Terrestrial
1912 Flashlight-Cell Holder
1950 Hot Plate, Electric, Three-Heat, Single Unit
1955 Hot Plate, Single Unit
2125 Kits
2170 Lamp, Electric, Miniature
2235 Lenses, Demonstration Set
2335 Magnet, Bar
2340 Magnet, Bar Alnico
2365 Magnet, Horseshoe
2370 Magnet, Horseshoe, Alnico
2390 Magnet, U-Shaped
2450 Magnifier, Reading Glass
2575 Meter Sticks
2625 Microscope, Elementary
3015 Net, Insect, Collapsible
3320 Prism, Equilateral
3325 Prism, Equilateral, Lucite
3555 Receptacles for Miniature Electric Lamps
3615 Rod, Glass
3820 Spatula, Stainless Steel
4125 Test Tubes, Borosilicate
4170 Thermometer, Centigrade, Fahrenheit, Combined Scale
4175 Thermometer, Centigrade, −10° to +110°
4190 Thermometer, Large, Wall
4270 Tools
4535 Tubing, Glass
4540 Tubing, Rubber and Plastic
Test Meter
4610 Volt-Anemometer, Battery

Elementary Science: Standard

0092 Anemometer, Portable
0110 Ant Nest, Observation
0112 Ant Nest, Observation
0115 Aquarium
0120 Aquarium Aerator
0155 Atoms and Molecules, Magnetic
0210 Balance, Fulham
0230 Balance, Spring
0240 Balance, Spring, Dial Scale
0280 Ball and Ring
0300 Barometer, Aneroid
0305 Barometer, Mercury
0310 Barometer, Mercury, Demonstration
0410 Block, Cubic Foot, Dissectible
0445 Board, Spreading, Insect
0635 Cage, Animal
0640 Cage, Animal, Collapsible

[1] From "Subject Lists of Equipment," *Purchase Guide for Programs in Science, Mathematics, Modern Foreign Languages* by Council of Chief State School Officers with the assistance of Educational Facilities Laboratories, Inc., National Science Foundation, and others, 1959, and *Supplement*, 1961. Boston: Ginn and Company.

0645 Cage, Insect
0702 Camera, 35 mm.
0740 Case, Insect Specimen, Storage
0965 Collection, Rock and Mineral, Demonstration
1085 Convection Apparatus
1092 Copying Machine, Transparency Maker
1100 Cork Borers, Hand
1240 Dish, Evaporating, Porcelain
1245 Dish, Laboratory, Plastic
1250 Dish, Large Borosilicate
1395 Electromagnet, Ironclad, Lifting
1457 Filters, Light, Plastic Set
1595 Forceps, Straight
1620 Funnels, Filtering, 60°, Polyethylene
1640 Funnel Tube, Thistle Top
1760 Germinating Box
1780 Globe
1790 Globe, Celestial
1795 Globe, Hall Tellurian
1875 Gyroscope, Simple Form
1990 Hygrometer, Wet and Dry Bulb
1995 Hygrometer, Wet and Dry Bulb with Tables
2015 Illuminator, Incandescent Projection Bulb
2040 Incubator, Egg
2100 Jar, Battery, Cylindrical
2125 Kits
2155 Lamp, Alcohol
2165 Lamp, Chimney
2300 Liter Block, Dissectible
2345 Magnet, Bar, Cylindrical Alnico
2360 Magnet, Electromagnet, Lifting Type
2395 Magnet, Wobbly Bar
2435 Magnifier, Coddington
2440 Magnifier, Dissecting
2455 Magnifiers, Pocket, Folding
2485 Map, Slated or Blackboard
2500 Map, U.S., Relief, Large
2510 Mat, Asbestos
2520 Measures, Liquid, Metric
2615 Microprojector with Two Objectives
2625 Microscope, Elementary
2685 Mirror, Plane
2765 Model, Gas Engine
2865 Model, Steam Engine, Locomotive Design
2905 Model, Water Wheel
2915 Models, Dinosaur
2945 Motor, Battery Operated
2950 Motor, Electric, St. Louis
3005 Needle, Magnetic, Mounted
3030 Net, Towing
3070 Organ Pipe
3220 Pins, Insect
3250 Planetarium, Trippensee, Hand Driven
3300 Power Supply, Electric, Low Voltage
3360 Projection Screen
3365 Projector, Filmstrip and Slide
3367 Projector, Opaque
3370 Projector, Overhead
3375 Projector, 16 mm., Motion Picture, Sound
3376 Projector, Motion Picture, Sound
3377 Projector, Slide, 3¼" x 4"
3380 Projector Stand
3415 Pulley
3485 Psychrometer, Sling
3515 Radiometer
3520 Rain Gauge
3550 Receiver, Telephone
3650 Ruler, English and Metric Scales
3740 Slide, Cover Glass, Microscope
3780 Slides, Microscope, Plain
3940 Steam Engine, Electrically Heated
4020 Support Stand, Metal, Ring Stand
4025 Support Stand, Wooden
4030 Support, Test Tube
4035 Support, Test Tube, Polyethylene
4075 Tape, Measuring, Metric and English
4105 Telegraph Set
4120 Terrarium
4165 Thermometer, Alcohol Filled
4180 Thermometer, Clinical, Oral
4185 Thermometer, Dial Type
4200 Thermometer, Outdoor Weather
4245 Timer, Interval, Spring Wound
4255 Timer, Stop Watch

4275 Top, Color
4320 Transformer, Small
4355 Transmitter, Telephone
4395 Trough, Pneumatic
4560 Tuning Forks, Set
4605 Vivarium
4620 Wagon, Laboratory
4625 Wagon, Laboratory, Stainless Steel
4700 Weights, Brass, English Units
4705 Weights, Iron, English Units
4725 Weights, Slotted, Metric, Small
4765 Xylophone, Eight Bars

Elementary Science: Advanced

0055 Altimeter, Auto Type
0095 Anemometer, Weather Instrument Type
0125 Aquarium, Heater and Thermostat
0165 Autoclave, Steam Pressure
0225 Balance, Single Beam, Avoirdupois and Metric
0260 Balance, Triple Beam, Low Form, Heavy Duty
0285 Bar, Compound
0380 Bee Hive, Observation
0405 Binocular, Wide Field
0435 Board, Dissecting, Animal
0530 Bottle, Vacuum
0605 Burner, Bunsen
0610 Burner, Propane, Disposable Cylinder
0695 Camera, Pinhole
0697 Camera, Motion Picture, 8 mm.
0698 Camera, Motion Picture, 16 mm.
0770 Cell, Student Demonstration
0775 Center of Gravity Apparatus
0780 Center of Gravity Apparatus, Rotator Accessory
0785 Center of Gravity Apparatus, Set
0810 Chart, the Elements
0825 Chart, Periodic, Long Form
0852 Charts, Geology and Astronomy
0855 Charts, Life History and Habitat
0900 Cloud Apparatus
0960 Collection, Fossil
0970 Collection, Rock and Mineral, Study
0995 Color Disks with Motor
1045 Conductometer for Heat
1090 Convection Apparatus, Liquids
1180 Cylinder, Graduated
1195 Density Cylinder
1275 Dissecting Set, Student
1325 Earphones
1350 Electrical Circuit, Basic, Kit
1380 Electrolysis Apparatus, Hoffman
1430 Electroscope, Flask Form
1460 Filters, Light, Set
1530 Flower Press
1540 Fluorescent Minerals Kit
1800 Globe, Magnetic
1860 Gyroscope with Counterpoise
1865 Gyroscope with Gimbal Rings
2110 Jar, Bell, High, Solid Top
2125 Kits
2275 "Light-Pipe," Rod
2315 Magne-Poster of Earth and Moon
2325 Magne-Poster of Planets
2375 Magnet, Model
2400 Magnets, Floating
2410 Magnetic Needle, Dipping
2415 Magnetizer
2505 Map, U. S., Relief, Puzzle
2610 Microprojector with Three Objectives
2705 Model, Airplane
2735 Model, Ear, Separable
2745 Model, Eye, Separable
2750 Model, Flower
2755 Model, Force Pump
2775 Model, Gasoline and Diesel Engine
2800 Model, Human Skeleton
2820 Model, Leaf
2825 Model, Lift Pump
2830 Model, Lung Demonstration
2870 Model, Stem, Dicotyledon
2875 Model, Stem, Monocotyledon
2940 Motor Assembly Kit
2985 Mounts, Riker
3075 Organ Pipes, Set
3080 Orrery, Shadow (Planetarium)

3430 Pulse Glass, Large Form
3440 Pump, Air, Large Size
3445 Pump, Air, Small Size
3465 Pump, with Pump Plate, Hand Driven
3620 Rod, Permalloy
3635 Rotator, Hand Driven
3720 Simple Machines, Demonstration
3800 Soil Test Set
4005 Sun Dial
4115 Telescope, Three-inch, Refracting
4195 Thermometer, Maximum-minimum
4210 Thermometer, Soil
4235 Timer, Clock, Electric, Stop
4405 Tube, Barometer
4570 Vasculum
4745 Whistle, Galton's

Appendix II.—Science Supplies and Equipment for Elementary Schools, Grades 1-6[1]

I.—Chemicals

Item number	Article	Code	Unit	Suggested maximum quantity per science room	Unit price
205	Ammonium dichromate	18–024	1-lb. screw-cap bottle	1	
535	Fehlings Solution A	18–015	do	1	
536	Fehlings Solution B	18–016	do	1	
----	Fertilizer, powder	18–203	1-lb. carton	1	
570	Formaldehyde, 40 percent solution	18–354	1-lb. screw-cap bottle	1	
----	Iodine, tincture of	18–129	4-oz. bottle	1	
655	Iron filings—NF, 40 mesh, oil-free	18–096	1-lb. screw-cap bottle	1	
----	Mercury, redistilled (4-oz. bottle)	18–025	4-oz. bottle	2	
----	Plaster of Paris (patching plaster, 5-lb. bag)	18–098	Bag	5	
----	Soda, baking—12-oz. carton	08–008	Carton	1	
1191	Sulfur, sublimed	18–169	1-lb. carton	1	
----	Vermiculite, 3½-lb. bag	18–202	Bag	1	
----	Vinegar, distilled	18–106	1-qt. bottle	1	
1270	Zinc, metal, dust—powder	18–108	1-lb. screw-cap bottle	3	

II.—Flammables[2]

Item	Estimated yearly need	Code	Unit	Suggested maximum quantity per science room	Unit price
Acetone		18–213	1-lb. screw-cap bottle.	1 to a room	
Alcohol, methyl		18–214	do	2 to a room	

[1] Exact Science Department, Division of Instruction, Detroit Public Schools, March 1959.

[2] Use Flammable Requisition (Form 46) when requisitioning flammables.

Note 1.—This is for estimating yearly needs only—*do not requisition flammables at this time.*

III.—Glassware, Porcelain, Pyrex

Item number	Article	Code	Unit	Suggested maximum quantity per science room	Unit price
3430	Barometer tube, siphon form	18-257	Each	1	
1810	Beaker, Griffin (250 ml.)—low form, with spout	18-042	do	2	
1450	Bottle, wide mouth (8-oz.) to fit No. 6 rubber stopper	18-031	do	12	
	Bottle, Homeopathic (vial)—with plastic screw cap, cap. 30 ml.	18-070	Dozen	2	
1850	Flask, boiling (Florence) (500 ml.)—Pyrex 4060	18-044	Each	1	
1875	Flask, Erlenmeyer (125 ml.)—Pyrex 4980	18-233	do	3	
1880	Flask, Erlenmeyer (250 ml.)—Pyrex 4980	18-234	do	3	
	Flower pot saucer (6-in.), china or glass, machine made	18-284	do	1	
1515	Funnel tube, conical top	18-047	do	1	
	Glass, water (9-oz.), straight sides, not fluted, clear	08-451	do	3	
1720	Mortar, porcelain (70 ml.) with pestle	18-039	do	1	
1685	Staining dish (300 ml.)	18-068	do	6	
1910	Test tube (18 mm. by 150 mm.) with rim, Pyrex 9800	18-235	do	12	
1911	Test tube (25 mm by 150 mm.) with rim, Pyrex 9800	18-236	do	12	

IV.—Cork and Rubber

2000	Balloon, rubber (pkg. of 12)	18-368	Package	1	
2005	Corks, No. 6 (pkg. of 100)	18-363	do	1	
2010	Corks, No. 8 (pkg. of 100)	18-364	do	1	
2015	Corks, No. 10 (pkg. of 100)	18-365	do	1	
2025	Rubber dam, 3-ft. wide	18-050	Foot	1	
	Stopper, rubber, pure gum, sulfur free, SAMA standard size				
2033	No. 3, solid	18-371	Each	4	
2034	No. 4, solid	18-372	do	4	
2035	No. 5, solid	18-051	do	4	
2036	No. 6, solid	18-373	do	4	
2043	No. 3, one-hole	18-375	do	4	
2044	No. 4, one-hole	18-376	do	4	
2045	No. 5, one-hole	18-052	do	4	
2046	No. 6, one-hole	18-377	do	4	
2053	No. 3, two-hole	18-378	do	4	
2054	No. 4, two-hole	18-379	do	4	
2055	No. 5, two-hole	18-380	do	4	
2056	No. 6, two-hole	18-381	do	4	
2061	Tubing, rubber (amber), ID 3/16-in. by 1/16-in. wall	18-054	Foot	3	
2065	Tubing, rubber (red), ID 3/8-in. by 1/16-in. wall	18-055	do	6	

V.—General Supplies

Item number	Article	Code	Unit	Suggested maximum quantity per science room	Unit price
-----	Adhesive, bulletin board (box of 16 sticks)	18–008	Box	1	-----
-----	Aluminum foil (25 feet), 18-in. wide, heavy duty	08–190	Package	1	-----
2205	Aquarium aerator, 110 VAC	18–249	Each	1	-----
-----	Aquarium aerator air release, porous stone air breaker	18–248	do	3	-----
-----	Aquarium aerator gang valve, 3-way	18–056	do	1	-----
-----	Aquarium heater thermostat unit, 110V, with pilot light, 8-in., 75W	18–061	do	1	-----
-----	Aquarium sand (coarse) No. 5 Ohio quartz gravel (25-lb. bag)	18–057	Bag	1	-----
3005	Ball and ring apparatus	18–253	Each	1	-----
-----	Bandage, adhesive (1-in.), in metal container	06–101	Roll	1	-----
-----	Brush, counter	09–016	Each	1	-----
3935	Brush, test tube, bristled end fan tip	18–073	do	1	-----
-----	Burner, alconol lamp, glass, 8-oz., with glass cap	18–112	do	1	-----
2625	Cell, demonstration (student's)	18–076	do	1	-----
-----	Cement, airplane, 2-oz. tube	18–011	do	1	-----
4010	Clamp, burette	18–077	do	1	-----
4045	Clamp, test tube	18–074	do	2	-----
-----	Compass, magnet (dia. 50 mm.), metal case, agate bearing, lock	18–081	do	1	-----
-----	Compass, magnetic (dia. 45 mm.), metal case	18–082	do	6	-----
-----	Dry cells (1.5 v.)	09–718	do	9	-----
-----	Electric bell	09–719	do	3	-----
-----	Electric push button	09–717	do	3	-----
2255	Fish food, natural, 3-oz. jar	18–063	Jar	1	-----
-----	File, triangular, 8-in.	09–186	Each	1	-----
-----	Flashlight, 2 cell	18–084	do	1	-----
-----	Flats, Wood, 11 in. by 22 in. by 2¼ in.	18–182	do	2	-----
2265	Flower pot, 3-in., standard tall form	18–282	do	1	-----
2267	Flower pot, 5-in., standard tall form	18–281	do	1	-----
2269	Flower pot, 8-in., standard tall form	18–283	do	1	-----
2270	Flower pot, for bulbs, 8-in., squat form	18–345	do	1	-----
-----	Flower pot, hanging, with bracket	18–028	do	1	-----
-----	Gauze, wire (asbestos center), 5-in. by 5-in., 10-mesh	18–060	do	2	-----

Item number	Article	Code	Unit	Suggested maximum quantity per science room	Unit price
-----	Hammer, nail, 7-oz.	09-192	-----do----	1	-----
-----	Hardware, cloth, galvanized, ¼-in. by ¼-in. mesh, No. 424, width 24 in. by 10 ft. long	18-086	10 feet----	1	-----
-----	Hoe, garden	18-206	Each -----	3	-----
1526	Jar, battery (1 gal.)	18-038	-----do----	5	-----
1530	Jar, museum (16 oz.), bakelite screw cap, high form	18-072	Dozen ----	1	-----
-----	Knife, paring	08-366	Each -----	6	-----
-----	Lamp, miniature (2 v.-.06 a.) screw base No. 48 (box of 10)	18-071	Box ------	1	-----
4115	Magnesium metal ribbon, 1-oz. roll	18-022	Roll -----	1	-----
-----	Magnifiers, reading glass. dia. 3 in., metal rim	18-130	Each -----	3	-----
1535	Medicine dropper	18-121	Dozen ----	1	-----
-----	Magnet, bar, Alnico, rectangular (1.9 by 0.7 by 15 cm.)	18-446	Each -----	12	-----
2770	Magnet, cylindrical, Alnico, 9 by 125 mm., a pair	18-305	Pair -----	3	-----
-----	Magnet, horseshoe, Alnico, hook attached to keeper, 3 by 3.7 by 1 cm.	18-090	Each -----	2	-----
2780	Magnet, natural (lodestone)	18-092	-----do----	3	-----
-----	Needles, blunt, No. 17 (paper of 5)	07-064	Paper ----	5	-----
-----	Pan, cake—9 in. by 1½ in.	18-201	Each -----	10	-----
4135	Paper, litmus, blue, vial of 100	18-020	Vial -----	2	-----
4136	Paper, litmus, red, vial of 100	18-021	-----do----	2	-----
-----	Paper, Ammonia print—8 in. by 11 in. (pkg. of 50 sheets)	18-097	Package --	1	-----
-----	Peat moss	18-184	-----do----	4	-----
2835	Pith balls, assorted colors	18-095	Dozen ----	1	-----
3235	Prism, equilateral, 28 mm. faces, 75 mm. long	18-103	Each -----	1	-----
3650	Pulley, single sheave	18-207	-----do----	4	-----
3651	Pulley, double sheave	18-208	-----do----	2	-----
3652	Pulley, triple sheave	18-209	-----do----	2	-----
4145	Rack, test tube (wood), 6 holes, 6 drying pans	18-078	-----do----	1	-----
-----	Rake, garden	18-204	-----do----	3	-----
-----	Receptacle, miniature (socket), porcelain, screw base	18-406	-----do----	6	-----
4150	Ring, 4 in., with clamp	18-079	-----do----	2	-----
2885	Rod, friction, glass	18-091	-----do----	1	-----
2890	Rod, friction, hard rubber, vulcanite	18-140	-----do----	1	-----
-----	Screwdriver (6-in., slim)	13-213	-----do----	1	-----

Item number	Article	Code	Unit	Suggested maximum quantity per science room	Unit price
-----	Seeds, lettuce	18-186	Package	1	-----
-----	Seeds, lima bean	18-185	----do----	2	-----
-----	Seeds, pea	18-187	----do----	1	-----
-----	Seeds, radish	18-188	----do----	1	-----
-----	Seeds, tomato	18-189	----do----	3	-----
-----	Shears, pruning	18-099	Each	1	-----
-----	Shovel, garden	18-205	----do----	3	-----
-----	Sprayer, hand gun, 1-qt. size, glass jar	18-127	----do----	1	-----
-----	Spring balance, circular dial, 2000 gm., 72 oz.	18-327	----do----	2	-----
-----	Sprinkling can, 6-qt. size	18-147	----do----	1	-----
4205	Support, iron, rectangular base	18-080	----do----	2	-----
2915	Switch, knife, SPST, porcelain base	18-407	----do----	4	-----
-----	Thermometer (C° and F°—20° to 110° C, —4° to 230° F)	18-336	----do----	4	-----
3300	Thermometer, fever, oral	18-089	----do----	1	-----
-----	Thermometer, window	18-102	----do----	1	-----
-----	Tin snips, 10-in., straight	13-362	----do----	1	-----
-----	Trowell, curved	18-128	----do----	12	-----
-----	Tubing (tygon), flexible, ID 3/16-in. by 1/16-in. wall	18-104	Foot	4	-----
-----	Tuning fork, adjustable	18-441	Each	1	-----
-----	Tuning fork (256 c.p.s.)	18-115	----do----	6	-----
-----	Ultraviolet light source, with 250 w. bulb, 9-in. reflector, adjustable clamp	18-343	----do----	1	-----
-----	Ultraviolet light source, bulb, 250 w., med. screw base	18-344	----do----	As needed	-----
-----	Wire, copper, DCC, No. 18—1-lb. spool	18-058	----do----	1	-----
-----	Wire, copper, DCC, No. 24—1 lb. spool	18-059	----do----	1	-----
-----	Wire screen, 24-in. wide, 14 mesh	18-117	Yard	4	-----
	Bulbs [3]				
-----	Bulb, daffodils	18-178	Dozen	1	-----
-----	Bulb, tulips	18-179	----do----	1	-----
-----	Bulb, narcissus, paper white (6 per pkg.)	18-180	Package	1	-----
-----	Bulb, lily	18-181	Each	3	-----

[3] Please use a separate requisition for each of the following items

VI.—Equipment

Please use a separate requisition for equipment items.

A RETURN SLIP must accompany EACH requisition for REPLACEMENT of an equipment item.

Item number	Article	Code	Unit	Suggested maximum quantity per science room	Unit price
5015	Aquarium (3 gal.) with cover	18–107	Each	1	-----
5016	Aquarium (5 gal.) with cover	18–109	do	2	-----
5017	Aquarium (10 gal.) with cover	18–110	do	1	-----
-----	Barometer, aneroid, wood casing, 3¼-in. open center dial, scale 27–31 in. with set hand and knob	18–069	do	1	-----
-----	Hot plate, 110 v. a.c. or d.c.	18–183	do	1	-----
-----	Microscope, micrometer fine adjustment, 5 aperture revolving substage condenser, flat and concave substage mirror, 3 Huygenian eyepieces 5x, 10x, 15x, turret with 4 achromatic objectives 5x, 10x, 40x, 60x, magnification from 25x to 900x		do	1	-----

Appendix III.—Science K-6 Equipment and Supplies[1]

Equipment

Air pump (bicycle pump)
Alcohol burner
Aneroid barometer
Animal cages
Aquarium
Bell, electric
Clamps for rubber tubing
Compass, magnetic
Compound microscope
Dry cells, several
Ebonite or amber rods
Electric hot plate
Electric lamps and sockets, 1⅓ and 3 volts
Electric motor, demonstration motor
Extension cords
Field glasses
Funnels
Fuses
Glass funnel and rubber stopper
Glass, microscope slides
Glass plates or panes
Glass rod
Glass tubing, various sizes
Insect cages
Insect killing bottle
Insect mounts
Lodestone
Magnets: bar, horseshoe, U-type Alnico
Magnifying lens, large size
Mercurial barometer
Prism, triangular
Pulleys, assorted sizes with tackle-block
Rain gage
Ring stand, iron, with clamp
Rubber stoppers, assorted sizes
Rubber tubing, assorted sizes
Sand tray
Socket for 1½-volt bulb
Sprinkling can
Switches, push button and knife
Tea kettle
Terrarium or herbarium
Thermometers (clinical, indoor, outdoor)
Tongs, crucible
Tripod
Tripod lens
Tuning fork
Wheels, various sizes

Supplies

Alcohol (rubbing)
Asbestos
Baking soda
Borax
Bulbs, narcissus, tulip, etc.
Bulbs, incandescent and flashlight
Candles
Carbon tetrachloride
Cardboard
Cement
Clay, modeling
Corks, assorted sizes
Cornstarch
Flashlight
Hydrogen peroxide
Iodine
Iron filings
Mercurochrome
Nails, assorted sizes
Nuts and bolts, assorted sizes

[1] Adapted from New York State Education Department, Bureau of Curriculum Development, *Science K–6 Equipment and Supplies*. Albany, N. Y.: the Department, 1958.

Paper clips
Pins
Plaster of paris
Rubber bands
Screws, assorted sizes
Seeds, flowers and vegetables
Silk thread
Sockets, plastic
Soil, potting loam
Spoons
Tacks
Wire, copper lamp cords; bell wire, magnet DCC No. 20 and magnet DCC No. 30; chromel No. 22
Wood, assorted sizes and pieces

Environmental Materials

Aluminum foil
Aluminum pans
Balloons (toys)
Baseball
Bicycle
Bicycle tire and tube
Birdhouses
Blotters
Bones (chicken, etc.)
Bottles (pop, milk, etc.)
Broom straws
Brushes (paint, etc.)
Cans, all sizes
Castor oil
Cellophane
Chalk
Cheesecloth
Cider jugs
Clay pipes
Clorox
Cloth (all kinds)
Clothespins (spring type)
Coal
Coasters
Coathangers
Cocoa butter
Cold cream
Collections of rocks and minerals
Colored paper
Cotton
Crayons
Curtain rods
Dishes, plastic, china
Drums
Dry ice
Egg
Electric fan
Eye droppers
Fan
Fertilizer
Fish
Fish bowls
Flats for germinating seed
Flowerpots
Fluorescent light tubes
Food
Food coloring
Fossils
Fountain pen
Garden hose
Globe
Glue
Golf balls
Gravel
Hatbox
Hatpin
Ice
Ink (several kinds)
Insects
Jars (all kinds)
Jar tops
Juice, lemon, etc.
Kites
Knitting needles
Lard
Leather
Lime
Lime water
Linseed oil
Machine oil
Mailing tubes
Marbles
Medicine dropper
Megaphone
Mineral oil
Mirrors
Mosquito screen and netting
Mustard seed
Nails
Needles
Net and strainer
Newspapers
Paint
Paint cans

Pans, all kinds
Paper bags
Paper cups
Paper towels
Paraffin
Photographic film
Ping-pong ball
Pitchers
Plants
Potatoes
Rags
Rhubarb
Rope
Rosin
Rubber balls
Salt
Sand
Sawdust
Scotch tape
Screw eyes
Shaving soap
Shoetrees
Snow
Soap
Sponges
Spools
Steel wool
Stones
Stopwatch
Straws
String
Sugar
Sunlamp
Tape, friction, adhesive
Tennis balls
Thread
Tire valve
Toothbrushes
Toys, toy machines—airplanes, gyroscope, dump trucks, friction toys, wind-ups, and roll backs, etc.
Turpentine
Umbrella
Vaseline
Vinegar
Violin
Watch
Watercolors
Waterglass
Wax paper
Wax, sealing, etc.
Wire
Wood, scraps
Yardstick

Tools

Teachers need to have a few good quality tools available not only for setting up and for building science equipment, but also for the many other types of projects that are usually in progress in modern schools. Those suggested are:

Adjustable wrench
Brace and bits
Claw hammer
Files, triangular and flat
Knife
Pliers, common and electrician's
Saw
Scissors
Screwdrivers
Tape measure
Tin snippers
Trowel
Wedge or chisel

Appendix IV.—A Basic Equipment List[1]

I. Materials and Equipment From Local Stores or Science Supply Companies

Garden Tools (Child Size)

hoe
rake
spade
trowel

Glassware

bottle, nursing (Pyrex)
glass tank with cover, 3 to 6 gallons
glass tubing
lamp chimney
medicine dropper
mirrors, concave and convex
petri dishes
prism
Pyrex beaker, approx. 1-cup size
Pyrex flask, approx. 1-pint size
reading glass
test tubes, 6" x ¾"

Magnetism and Electricity

bell and buzzer
compass, magnetic
dry cells, 1½ volts
dry cell holder (for flashlight cells)
flashlight
fur
glass rod
hard rubber rod
iron filings
lamps, flashlight bulbs
lodestone
magnets—bar, U, and horseshoe
motor, toy
pith balls or puffed wheat
sockets (for flashlight bulbs)
switches—push-button, knife, toggle
tape, friction
telephone receiver or earphone
telephone transmitter
wire, copper—insulated No. 22

Miscellaneous

alcohol
alum
ammonia
asbestos pad
asbestos, powdered
balls
corks, assorted sizes
cotton batting
dyes
funnel
iodine
lime
meal worms
needles
pans
plaster of Paris
plastic molding material
plunger, rubber
pulleys
ribbon
scoop
spring balance
steel tape
steel wool
stoppers—rubber, solid, 1- and 2-hole, assorted sizes
teakettle
test tube brush
test tube holder
thermometer—candy, clinical, indoor-outdoor
thread
tongs
tubing, rubber or plastic (to fit glass tubing 3/16" inside diam.)
tubing, rubber or plastic ½" diam.
tuning forks (of different pitch)
tweezers
wire, steel

[1] From *No.* 36, National Science Teachers Association *Elementary School Science Bulletin,* March 1958.

II. Home and School Materials

blotter
bottles
boxes
bulbs, light (discarded)
candles
cellophane
cement, building
cement, rubber
cereal, puffed wheat, bran
chalk
cloth
cups and saucers
cups, measuring
electrical appliances (discarded) i.e., hot pad, iron, radio, motor
flannel
flower pots
fuses (discarded)
globe
ink
jars
jugs
knives and forks
labels
maps
matches
metal scraps—zinc, aluminum, copper
mirrors
musical instruments
paper, construction
paper, wrapping
paper clips
paraffin
paring knife
paste
pins
plates
rubber bands
ruler
salt
sawdust
scissors
seeds
soda
soil—clay, loam, sand
sponge
spoons, metal, wooden
starch
string
sugar
syrup
thumbtacks
tin cans
toys
tumblers
vegetable coloring
vinegar
window glass
yardstick

III. Materials and Tools for Construction

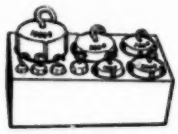
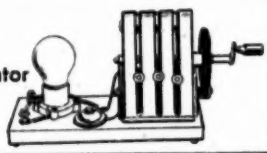
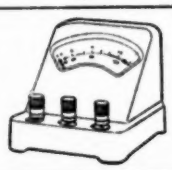
Materials

acetate, sheets or discarded X-ray film
bolts
brush
C-clamp
glue
hardware cloth
hooks and hinges
nails
nuts
paints
paint thinner
pans—cake, cookie, pie
sandpaper
screening
screws
tacks
varnish

Tools

brace and bit
drill
file
glass cutter
hammer
pliers
saw
screw driver
soldering iron and solder
tin snip

Appendix V.—Science Equipment[1]

Item No.	Item and Picture	Possible Uses	Grade Levels	(✓)	Building Storage Location
1	Balance, spring	• anytime there is a use for measuring weights, for example: • keeping weight charts on animals • when showing forces required in simple machines units	K–6		
2	Weights (set) 	• anytime a known weight is needed, for example: • when showing advantages of simple machines • when using items on homemade balance	K–6		
3	Barometer (aneroid)	• to show air pressure, weather forecasting	6		
4	Generator 	• use in experiments with electricity	4		
5	Gyroscope	• illustrating the laws of rotation	6		
6	Conductometer	• experiments in the principles of heat	5		
7	Voltmeter 	• measuring volts in electricity	4,6		
8	Electroscope	• use in experiments with static electricity	4		

(✓) Available in Building

[1] From appendix, *Instructional Guide for Elementary School Science, Grades 1–6.* Denver, Colo.: Denver Public Schools, 1960.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1961—599488